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EDUCATION OF THE ADOLESCENT

IN a report to King George's Jubilee Trust Fund on the needs of youth, made shortly before the outbreak of war in 1939, Dr. A. E. Morgan urged the importance of a system of at least part-time continued education carried on during the working-day up to the age of eighteen years. We could not afford, he maintained, to let the boy or girl slip out of our care even at sixteen, let alone at fifteen. How far even yet we permit invaluable human capital thus to run to waste was shown in the report on "Early Leaving" which was published early in 1955; and perhaps with all the more force in that this report recognized that, for some boys and girls, no useful purpose would be served by keeping them at school even after fifteen years of age.

The need for some elasticity, however, increases the importance of due attention to the needs of youth in leisure and in recreation. Although, however, there are reassuring passages in the study of the influences affecting the upbringing of young people which the Council of King George's Jubilee Trust issued towards the end of 1955 under the title "Citizens of Tomorrow"*, it is disturbing to find how closely the picture painted resembles that depicted by Dr. Morgan sixteen years earlier. To-day, even more than before the War, pleasure has ousted work as the main preoccupation of life: work is no longer an absorbing means of expression, but merely the device by which we can buy the comforts we desire and expect. It is endured for the reward to be reaped thereafter, and this is as true of the juvenile as of the adult worker.

Such an attitude strikes at the very root of voluntary work and service; and if these are to continue, the outlook and attitude of youth must be changed. In this, as elsewhere, the foundations of real national fitness must, as Dr. Morgan remarked, be laid on the bedrock of youth. Elsewhere he wrote of the advisability at some points of overcoming vested interests, where they may clash with the interests of youth, of the importance of recognizing that paid leadership in clubs and youth centres is a profession and that it is essentially educational, and that the problem of finding the right leaders in sufficient quantity is a matter of national urgency. He looked to the universities for co-operation in developing appropriate facilities for the professional training of club leaders.

The study which the Trust has now published is based on the reports of four working parties which inquired, respectively, into four phases in the upbringing of young people in Britain: that of full-time attendance at school; the influence of employment in the period after leaving school; the influences of leisure time; and the period in the Services. Even more emphatically than Dr. Morgan, these reports are unanimous as to the profound and enduring influence of parents. The working parties agree that in recent years there has been some weakening of the sense of parental and personal responsibility, and that a return to Christian principles offers the best hope of fostering a renewed sense of such responsibility. Thirdly, all four reports are concerned with the problem of dealing with the gap, both in education and in life, which, for most boys, now exists between the end of school life at fifteen and entry into national service.

As regards national service itself, it is thought that there is little fundamentally wrong with the present system, and adjustments required are mostly within the scope of the Services themselves. The generally satisfactory means of educational advancement offered by the Services should, however, be more widely known; and it is also recommended that employers should be persuaded to recognize a special responsibility towards the boy of fifteen to eighteen so that during those critical years he may be given general and physical education as well as serious vocational training. Furthermore, to arrest the existing educational deterioration of those who leave school at fifteen and are not apprenticed, this working party, which discusses the period in the Services, recommends that the Government should give serious consideration to the possibility of hastening the establishment in Britain of county colleges.

Apart from raising the school-leaving age to sixteen, the establishment of county colleges—both steps for which the Education Acts of 1944 and 1946 provide—is the only legislative step suggested by the study, and if a choice has to be made between raising the school-leaving age and the establishment of county colleges, the latter should come first. Both working parties concerned with the period after leaving school stress the importance of county colleges, and agree that the time is now ripe for their establishment. That concerned with the influence of employment believes that if management, employers' associations, chambers of commerce, trade unions and local education authorities ensured the proper functioning of these colleges by doing everything possible to increase facilities for day release, most school leavers would no longer virtually cease systematic education at fifteen. That concerned with leisure-time influences is no less concerned to see county colleges introduced at the earliest possible moment, because it believes that such colleges will enable young people to live fuller and more complete lives, permitting some of the gaps in the Youth Employment Service to be stopped and making possible the general assertion of the principle that when young people begin to work they should be learners as well as earners. It does not, however, believe that such colleges will ever supersede the youth service or make it unnecessary.

This particular report has much to say about strengthening the youth service and, apart from the expenditure of more money on it, there are suggestions regarding the training of youth leaders and

* Citizens of Tomorrow: a Study of the Influences Affecting the Upbringing of Young People. Pp. 142. (London: Odhams Press, Ltd., 1955. Published on behalf of the Council of King George's Jubilee Trust.) 3s. net.

the development of new techniques which deserve attention. Like other of the working parties, it also suggests the establishment of a national youth advisory council, though not in quite so well-defined a form as the working party concerned with employment. The latter proposes a national joint advisory council for youth, responsible to the Lord President of the Council and charged with considering action on the recommendations of the report and continuing concern for such investigation into problems of transition from school to working life. This recommendation is endorsed by the Trust in its commentary, and is probably the most far-reaching suggestion of the whole study.

If the Government is not prepared forthwith to proceed with the establishment of county colleges, this recommendation at least should be implemented. It may require less immediate expenditure, but is almost certain to provide convincing evidence of the need for the expenditure on youth service and county colleges, etc., which the study recommends. Moreover, the establishment of county colleges has also recently been urged by Mr. M. L. Jacks in discussing the education of the young worker in his recent book, "The Education of Good Men"*. Mr. Jacks, seeing in the colleges of further education the precursors, on a voluntary basis, of the county colleges, emphasizes the value of the latter provided they are separated as completely as possible in terminology and all their associations from the world of school. One of their chief educational advantages is, he believes, in the opportunity such colleges afford in mixing boys and girls engaged in a great variety of occupations, and this variety should characterize every tutorial group.

Mr. Jacks believes also that the county colleges could meet the claims of religion, which he too emphasizes, provided religion is made a background to the life of the college, a normal and habitual element in its experience. Dr. P. F. R. Venables, in his recent book, "Technical Education", deplores the shelving of the county colleges as perhaps the bitterest of the post-war disappointments, and suggests we may wonder whether we will ever see a government with the wisdom and courage to establish county colleges. On a voluntary basis they will never meet the needs of more than a small fraction of the age-groups fifteen to sixteen years.

As a contribution to the provision of general education and offering a background for technical education even more than preventing the waste of human capital, it might be possible effectively to urge the development of the county colleges on the Government at the present moment. Mr. M. L. Jacks maintains that it is within the power and the duty of the schools to provide four things lacking in contemporary society: a respect for good work; a willingness for hard work; efficiency; and an ideal of service to be rendered to society in and through a man's daily work well done. All this bears profoundly on industrial efficiency and raising the level of productivity; and the survey of the relation of vocational and non-vocational further education and training which the National Institute of Adult Education published early in 1955 emphasizes particularly the value of residential education in this connexion. The very condition of living and studying together profoundly affects the flow of young people's sympathetic consciousness, and although the short-term residential colleges are still very new, they are already becoming well established.

The Committee which conducted this inquiry for the National Institute of Adult Education was greatly impressed with the value of even a short period of residence. It can easily turn interest into something much deeper, as well as transform the interest of the students for each other as people, and the Committee urged the establishment of intimate liaison between technical colleges and residential adult education colleges. In its view, residential colleges are in a unique position to mediate between the frequently divergent claims of the vocational and the non-vocational. They are ideally equipped to experiment with methods of teaching and discussion, and to discover what actual subjects can help to promote vocational and semi-vocational work of a liberal character. If the colleges succeed in the experiment with liberal vocational courses which they are conducting, the Committee hopes it will be possible to increase very considerably the number of residential colleges, so that they may make their contribution to technical education on a far wider scale.

The Committee thus suggests that a short residential course might come to be accepted as part of the vocational training of all full-time and day-release students. Concluding that lack of time excludes almost any of the values of a liberal education from vocational studies pursued at evening classes, except such as can be introduced through a broader treatment of the technical subject itself, it sees only one solution to this problem of general education for most young people: the establishment of county colleges. Only thus, it suggests, will further education be able to discharge its task of fostering a sense of pride in achievement and of responsibility in all levels of the working population.

This emphatic recommendation for the establishment of county colleges attracted little attention at the time. In the six months since the report was published, the recommendation has found strong support, however, not merely in the study published by the Council of King George's Jubilee Trust and in Mr. Jacks's book, but also in much that has happened in the industrial and economic life of Britain. Notably it would seem that the wider appreciation of the importance of an adequate general education at all levels, from that of the technician and operative to the scientist, technologist and manager, makes this an opportune moment to press the issue of county colleges as part of the provision for efficiently increasing the nation's production of technicians and technologists and scientists. It can be argued that it is an essential element in securing a continuous and increased supply of technologists, scientists and technicians who are really educated, and whose services will be far more efficiently used. Indeed, it

* The Education of Good Men. By M. L. Jacks. Pp. 192. (London: Victor Gollancz, Ltd., 1955.) 13*s.* 6*d.* net.

may not be too much to urge that, unless some such step is taken, as part of a considered programme taking full account of the requirements of the nation at all levels and of the resources available, short-term as well as long-term, plans for the expansion of technological and technical education may ruin the educational system of Britain and lead to economic disaster.

If these dangers are to be avoided, it is important that our ideas as to the county colleges should be clearly defined, and that the functions which they are to fulfil in adolescent education and their relation to technical education at least, if only indirectly to technological education and university education, can be convincingly stated. It must be realized that money spent on the county colleges means less money available elsewhere—less for the expansion of the technical colleges, for the development of a selected few into colleges of technology, for the extension of the scientific and technological departments of the universities themselves and the building of new schools. Our plans indeed at every level must be conceived with imagination, but our vision must be tempered with realism and with a sense of perspective and of the part which each unit is to play in the functioning of the whole. Mr. Jacks gives us no blue-print in his recent book, but a sense of perspective and of the relation of each part to the whole informs and illumines the full sweep of his diverse comments on the educational scheme. That he is provocative—at times deliberately so—is all to the good and adds to the value of a lively and stimulating book. It should be read by all interested in educational policy from whatever angle, and perhaps not least by those who, following Sir Eric Ashby's argument, are seeking so to reconstruct adult education as well as that of the adolescent that man can preserve his status as an individual, giving new meaning to his civic rights and illumining his political rights with understanding.

AN INTELLIGENT MAN'S GUIDE TO THEORETICAL PHYSICS

The Laws of Nature

By Prof. R. E. Peierls. Pp. 284. (London: George Allen and Unwin, Ltd., 1955.) 21*s.* net.

THIS is a book on theoretical physics, intended for a reader who may have no previous knowledge of the subject and very little mathematical equipment. The material may be divided into four sections, each occupying about sixty-five pages: the classical theory of particles and of fields in vacuum; the atomic theory of the nineteenth century; relativity and quantum theory; and sub-atomic physics (high-energy electrons, nuclei and mesons). It may be noted that two of these sections are devoted to classical physics and two to modern physics. Prof. R. E. Peierls covers a very wide range of topics, for he starts with an exposition of elementary mechanics and ends with the application of field theory to unstable particles. The general methods and aims of theoretical physicists are discussed in an introduction and a short concluding chapter.

Prof. Peierls avoids the use of mathematical processes by expressing in words the meaning of such concepts as differentiation, divergence and circulation. His treatment is naturally that of the theoretical physicist; for example, he is not directly concerned with the experiments of Faraday but translates the equations of Maxwell into the simplest words he can find and discusses the predictions derived from certain solutions. The application of theories is sometimes followed in considerable detail (for example, in the treatment of the vector model of the atom or in the discussion of different types of mesons and hyperons).

Rutherford once argued (over a tea-table) that since the table is seen by the light which it reflects and an α-particle by the light of the scintillation which it causes, therefore one sees the α-particle in the same sense as one sees the table. Rutherford could make more difficult propositions sound very convincing, and it is true that the table is a picture—a logical construct—of one type of experience and an α-particle of another. The α-particle is just as real as the tea-table and the equations of field theory are just as real as either, but the ideas of theoretical physics are both unfamiliar and subtle. A Martian, newly descended from his Flying Saucer, could be taught the language of everyday life by pointing at common objects and naming them. There would be some mistakes. Malinowski found when he learned the Polynesian languages by this semantic method that sometimes he got the word for a part or a quality of the thing indicated. This kind of misunderstanding is easily cleared up when there is a sufficient background of common simple experience. For lack of this background, a physicist who showed a non-scientist a scintillation and said 'α-particle' would probably give him the idea that an α-particle is a flash of light. Even many a professional physicist would understand little if Prof. Peierls pointed to an equation and said 'anti-proton'. His task of explaining in the language of everyday life theories that are derived from experience, which is so different from that of everyday life, is no easy one.

Two thousand years ago, Lucretius wrote a book on the laws of Nature. He wrote with a purpose—to combat the darkness of superstition by the light of a scientific understanding of natural phenomena. His burden was lighter than that of a modern writer. There was a shorter tale to tell, and Lucretius was able to include an interesting theory of ghosts and phantoms as well as some advice on love and marriage. Yet he recognized that he had no easy task in taking science to the layman. He explained that it was necessary to "smear the cup with honey" in order to persuade the child to drink the bitter medicine. He therefore wrote in verse and illustrated his argument with interesting tales. Modern writers on popular science do not break into verse, but they nearly all feel the necessity of doing something to gain the attention of an unwilling reader. They seek to show the 'wonder' of science by anecdotes, epigrams, paradoxes and daring extrapolations from the actual to the conjectural. Lucretius was read for his poetry, but his ideas made little impression on the Roman world. The modern writer is too often remembered for his style, the substance being forgotten.

Prof. Peierls seeks to convey not the wonder of theoretical physics but its logical structure. He

assumes that his reader is intelligent, that he wants to understand the subject, including the most difficult parts, and that he is prepared to make a considerable mental effort. None of the usual devices of 'popular' books is employed. The author tells a plain tale in simple language. This method cannot convey the elegance of the mathematics but, by using it, the author forces his reader to attend to the substance. He depends upon that alone to sustain the interest. My first impression was that too much detail had been included and too few illustrations, so that many readers would find the book difficult. I feared that rather few non-scientists would be sufficiently interested to complete the book. As an experimental scientist, I felt the need of some evidence and asked three friends to begin the book, not to proceed further than they felt inclined, and to inform me where they stopped. All three complained that the book was difficult, that there were not enough diagrams, that the argument was very involved in places, *but* each of them had finished the book. The number is too small for statistical conclusions, but perhaps the potential readers are more numerous than I thought. There may be quite a lot of people who prefer to climb a steep intellectual mountain—with the help of a qualified guide—rather than to look at photographs of the wonderful view from the top. In any event, it is well that one distinguished physicist should try the 'direct method' of teaching his subject to the layman.

Prof. Peierls says he wrote partly to clarify his own ideas. Nearly every professional physicist who reads this book will find that there is some point at which his own mind is less clear than he believed and that the author has both revealed and resolved the difficulty.

R. W. Ditchburn

FOSSIL PLANTS OF THE CARBONIFEROUS ROCKS OF GREAT BRITAIN

Memoirs of the Geological Survey of Great Britain
Palæontology. Vol. 4, Part 1: Fossil Plants of the Carboniferous Rocks of Great Britain. (Second Section.) By Dr. Robert Crookall. Pp. iv+84+24 plates. (London: H.M. Stationery Office, 1955.) £3.

THE first step in the publication of "Fossil Plants of the Carboniferous Rocks of Great Britain" was taken by Robert Kidston in Vol. 2 of the Memoirs of the Geological Survey, published in six parts between 1923 and 1925. They represented part of Dr. Kidston's researches on Carboniferous plants carried out during his long and active lifetime. Unfortunately, his death in 1924 put an end to this project and the description of British Carboniferous plants, which was largely based on his and the Geological Survey collections, was left incomplete. The parts which he completed dealt exclusively with the compression type of fossil plant and did not include petrifactions. The compression type of fossil is the common type encountered in sedimentary rocks and is of greater importance to the geologist than the petrifactions, which are mainly of botanical interest. The six parts included descriptions of most of the fern-like plants (ferns and pteridosperms). They are excellently illustrated memoirs and compare very favourably with any publication of a similar kind which appeared at that time. Similar illustrated memoirs had previously been published by French palæobotanists—Renault, Zeiller, Bertrand and others—in the "Études des Gites Minéraux", published under the auspices of the Ministry of Public Works; and Lesquereau, White and others described the coal measure floras of North America for the United States Geological Survey.

After a regrettably long interval, publication of the work started by Kidston has now been resumed, and it is very gratifying that the Geological Survey of Great Britain intends to continue this important work. In the interval, other countries, notably France, the Netherlands and Belgium, have produced magnificent monographs of plants of their coal-bearing formations and have to a certain extent anticipated part of the work Kidston had planned to do. Dr. Robert Crookall, author of this new part, while making use of some of Kidston's manuscripts and the magnificent Kidston Collection and other collections of the Geological Survey, has produced a volume which compares very favourably indeed with the earlier ones. He has brought our knowledge of the plants that he describes up to date and has added several new species to the British Carboniferous flora. In a clear and well-written introduction he explains the changes that have taken place in the scheme of classification of Carboniferous rocks since Kidston's time; these changes are largely due to the discussions and decisions taken at the congresses on Carboniferous stratigraphy held at Heerlen in the Netherlands in 1927, 1935 and 1952.

Dr. Crookall then describes the genera *Alethopteris* and *Lonchopteris*, two closely related genera of fern-like fronds which are almost certainly the foliage of pteridosperms. This is followed by the genus *Desmopteris*, a fern-like plant of uncertain affinities. He then describes the genera *Caulopteris* and *Megaphyton*, which are parts of stems that exhibit the scars left by the abscission of large fronds. *Caulopteris* and *Megaphyton* were evidently the stems of plants, some of which were almost certainly tree ferns, while some may have belonged to pteridosperms which had the habit of tree-ferns. Dr. Crookall describes several new species, one of *Caulopteris* and four of *Megaphyton*.

The descriptions are clear, and a comprehensive synonymy is given for each species. The photographic illustrations are excellent. This work is a worthy continuation of that started by Kidston, and it is to be hoped that other parts of this important series of publications on British Carboniferous plants will appear before long.

J. Walton

THE METAPHYSICAL STRAIN IN KANT

Kant's Metaphysics and Theory of Science
By Prof. Gottfried Martin. (Translated from the German by P. G. Lucas.) Pp. viii+218. (Manchester: Manchester University Press, 1955.) 21*s.* net.

IT was Hume who urged us to burn all metaphysical books, and Kant is often regarded as supporting him in this. What Kant is prized for is his elaboration of the principle that concepts gain significance only in so far as they serve to link actual or possible sense experiences, and, from this point of view, statements about what is not so conditioned have no sense. Kant, it is true, made many references to noumena, but these can be rejected as inconsistent with his

fundamental doctrine. This, however, involves modifications—especially of his ethical doctrine—so drastic as to make one wonder. Did Kant really mean that no significant statements can be made about what lies outside the range of the spatio-temporal? Did he even mean that there can be no good grounds for accepting such statements?

Prof. G. Martin answers no to these questions. He holds, on the contrary, that a positive attitude toward metaphysics is fundamental even in Kant's theory of knowledge. Phenomena are essentially appearances to beings whose experience arises from the unification of materials received through sense. Kant always assumes that these sense materials arise through the stimulation of the receptive consciousness by noumena. The unifying consciousness is itself a noumenon and experiences itself as such in its moral decisions. Prof. Martin draws this conclusion from Kant's ethical writings, but shows that it is already foreshadowed in the "Transcendental Dialectic". Kant argues on ethical grounds that the concepts of freedom, immortality and God are not empty, but have application to the noumenal world. He applies to noumena the categories of "unity, plurality, causality, community, possibility, actuality and necessity" (p. 198), suggests that there is some correspondence between the sensible entities in the world and things in themselves, and speaks of God as the author of things in themselves.

Prof. Martin contends that in all this Kant is not being inconsistent, but is continuing and developing a long metaphysical tradition. He illustrates this in great detail, and suggests that the best way of interpreting Kant's view is to say that the categories are applied to things in themselves—not in the basic sense in which they are applied to phenomena, but "in an analogical sense" which does not give rise to knowledge, but for which good reasons can be given. He thinks this can be defended; but he is mainly concerned with determining what Kant's actual views were, and his study is thoroughly interesting and suggestive. His discussion of Kant's theory of science (*Wissenschaftslehre*) deals only with the fundamental points, and, while it is very clear, contains nothing new, though it is well illustrated by references to modern developments in mathematics. The translation is admirable.

L. J. RUSSELL

QUANTITATIVE MICRO-ANALYSIS

Methods of Quantitative Micro-Analysis

Collected and edited by Dr. R. F. Milton and Dr. W. A. Waters. Second edition. Pp. xi + 742. (London: Edward Arnold (Publishers), Ltd., 1955.) 70*s*. net.

THIS book is the second edition of the well-known volume which was first published in 1949. The general climate of micro-chemistry has changed greatly in the interval. In 1949 the applications of micro-techniques were few and not very widely used, but at the present day they are ubiquitous. The change is due to the advance in instrumentation and also, no doubt, to the availability of good text-books on the subject. The present volume consists of the original text by Drs. R. F. Milton and W. A. Waters, assisted by G. Ingram, J. T. Stock and K. M. Wilson, to which have been added two new parts on chromatography and micro-biological assay by S. M. Partridge with T. Swain and A. J. Amos, respectively. The general lay-out of the book is the same as that of the first edition, and the text of the first six parts is identical with the old text, except for certain additions to bring it up to date. These are mainly in Part 4 on colorimetric analysis, where a description of some of the more recent absorptiometers and spectrophotometers is grafted to the original stem. No attempt is made to evaluate the relative usefulness of the new instruments.

As methods are given that are based on the measurement of the absorption spectra of the test substances, it would not be irrelevant to ask why there is no section dealing with emission spectrography, which is perhaps the most useful and widely practised of micro-methods available to the analyst. If the authors feel that this is too specialized a field for their book, they might perhaps refer to the subject as they have done to electrophoresis in Part 5 on p. 425. Flame-photometry, too, might well have received some attention, as it is extensively used at the present time. In the section dealing with specific colorimetric determinations (Part 4), the references could be, in some instances, usefully extended. Thus the later work of Somogyi (*J. Biol. Chem.*, **19**, 195; 1952) could be mentioned on p. 350. Under sugars, neither in the colorimetric section nor under chromatography is there a reference to the use of 2 : 3 : 5-triphenyltetrazolium chloride (Wallenfalls, K., *Angew. Chemie*, **23**, 491; 1953). Again, under benzene, p. 359, some reference could well be made to the important work of Dolin (*Indust. Eng. Chem., Anal. Ed.*, **15**, 242; 1943).

Part 7 deals with chromatography, and as everyone conversant with the modern literature will allow, it is quite impossible to compress this subject into eighty-three pages. The authors have kept to their usual plan of a short theoretical introduction followed by a good description of apparatus and technique, terminated by selected samples of detailed procedures. On p. 628, par. 3, they make some somewhat disparaging remarks about the accuracy of paper chromatography. These comments would, perhaps, have been better expressed as criticisms of the methods used for the final evaluation of the separated substances, for surely their separation on the paper is complete, even if no method exists for their accurate determination. In the inorganic field, the well-known book of Pollard and McOmie could, with advantage, be included in the references at the bottom of p. 628.

Part 8 is a description of methods of biological assay. The introduction follows the general plan of the book and is brief but adequate. The section dealing with the calculation of results is, perhaps, rather too mathematically profound for the brief treatment given to the rest of the subject. While the methods of E. C. Wood are, without doubt, of great value, it could well be stated that calculations based on simple graphs, used with intelligence, are capable of giving good results. Otherwise, analysts might reject these methods as being too complicated when, in fact, they are relatively easy to carry out.

The book as a whole is well produced, with bold chapter headings and satisfactory sub-headings. Both the author index and the subject index are easy to use. In the years to come, "Milton and Waters" will doubtless be a useful book for those engaged in micro-chemistry; but if a third edition is contemplated, additions to the existing work will not be enough. The time will then have arrived when nothing but a complete re-writing will suffice.

E. Q. LAWS

Proceedings of the 1954 Glasgow Conference on Nuclear and Meson Physics

Edited by E. H. Bellamy and R. G. Moorhouse. (Conference sponsored by the International Union of Pure and Applied Physics.) Pp. ix+352+5 plates. (London and New York: Pergamon Press, Ltd., 1955.) 63*s*. net.

THIS record of the 1954 Glasgow conference on nuclear and meson physics sponsored by the International Union of Pure and Applied Physics is divided into eight sections. The first four of these sections, which deal with nuclear constitution, properties and problems, occupy some two-thirds of the volume, while Part 5 collects the papers on π-mesons and Part 6 contains a few papers under the heading of field theory. The last two sections, dealing respectively with high-energy experimental techniques and with heavy mesons and hyperons, although short, are far from being the least interesting sections. Some particularly striking photographs illustrate Hildebrand's paper on bubble chambers.

Generally, each section of the book is introduced by one or two review papers; these give a comprehensive survey of the state of nuclear and meson physics in July 1954. Of some ninety other papers, the majority report on experimental results current at the time of the conference and discuss the implications of these results. As presented in the book, individual papers range in length from a few lines to several pages, and, although the space allocated to the various papers is not always an indication of their relative value, the editors and the publisher must be congratulated in making available a very adequate and readable account of the proceedings of the conference. Some significant points emerge in the edited version of the discussion which follows many of the papers.

To the many who may wish on occasion to use this book for reference purposes, the lack of an index will constitute a handicap. Paper titles, as listed at the beginning of the volume, are not in general a sufficient guide to the content of the papers. I feel that the extra labour required to index the subject-matter adequately would have made a useful book more valuable. J. C. Bower

A History of Red Tape

An Account of the Origin and Development of the Civil Service. By Sir John Craig. Pp. vii+211+12 plates. (London: Macdonald and Evans, Ltd., 1955.) 18*s*. net.

SIR JOHN CRAIG'S engaging account of the origin and development of the British Civil Service, as its sub-title indicates, goes farther back than E. W. Cohen's standard book, but makes no attempt to cover the decade and a half since that book was published, nor can it claim to be as serious a historical study. It is instead a readable and entertaining essay in which the author makes no attempt to disguise his own views and prejudices, particularly against the Trevelyan–Northcote reforms. On that question, and on the recruitment to the Civil Service by open competition, his highly critical remarks should be read in the light of Sir Edward Bridge's observations on the reforms of 1854 in a recent issue of the *Political Quarterly*, or of Prof. K. C. Wheare's lecture on "The Civil Service in the Constitution" to the University of London in 1954. Nevertheless, they remind the reader that there is another side and sound a note of caution to over-enthusiastic advocates of changes in methods of recruitment which R. K. Kelsall's recent study might stimulate. Sir John presents an immense array of facts in a most attractive guise and from an unusual angle, nor is the detail ever allowed to confuse the reader or his own prejudices to distort the picture. To the discussion on the adequacy of the Civil Service to the needs of to-day or the changes required in organization or elsewhere to increase its efficiency, his book makes no contribution, except in so far as it gives a clear understanding of how the Civil Service came to be, and a warning as to directions in which change or reform requires caution and great care. There are an interesting list, up to the end of the nineteenth century, of literary men who held posts in the Civil Service, and a short bibliography that is remarkable no less for the inclusions than for the omissions. R. B.

Ferromagnetic Domains

By Dr. K. H. Stewart. (Cambridge Monographs on Physics.) Pp. xi+176+7 plates. (Cambridge: At the University Press, 1954.) 25*s*. net.

IN his preface, Dr. K. H. Stewart states that "this book attempts to give a coherent outline of the fundamentals of domain behaviour . . .", and in the reviewer's opinion he has succeeded in giving a clear survey of the subject. It must be pointed out that the book was published more than a year ago, with the preface dated October 1953, and that there are few references to papers published after 1952.

An introductory chapter deals with the domain hypothesis and its implications, and then magneto-crystalline anisotropy, magnetostriction and the effects of stresses on magnetic properties are dealt with in some detail. There follow chapters on domain arrangements, with particular reference to single crystals, on the widths of, and energies in, domain walls, and on the factors affecting domain wall movement. The final two chapters briefly discuss time effects in magnetization and thermal energy changes involved in magnetization processes.

This is essentially a review of a subject which has expanded considerably in post-war years, and in only 170 pages a reader must expect some aspects to be dealt with most briefly. In particular, experimental detail—for example, the technique of producing domain powder patterns—has been reduced to the minimum. The book is well written and produced, and is fully illustrated with clear, though often rather small, diagrams. It will be of value to many, especially those whose interests lie on the fringe of this field and whose knowledge might otherwise end there. The information can easily be brought to the present date by consulting, for example, recent *Proceedings of the Physical Society*.

A Cuckoo in the House

By Maxwell Knight. Pp. ix+80+6 plates. (London: Methuen and Co., Ltd., 1955.) 7*s*. 6*d*. net.

MR. MAXWELL KNIGHT took a young cuckoo from the nest of its foster parents and brought it up by hand. It became quite domesticated and very confiding. It was allowed full freedom and flew where it pleased, but remained with him until migration time, when after a display of restlessness it disappeared. In this little book, illustrated with some excellent photographs, he tells about the bird, its disposition and behaviour, discussing at the same time various cuckoo problems and bird problems in general. F. P.

THE THERMAL HISTORY OF THE EARTH

By Prof. J. A. JACOBS and D. W. ALLAN
Department of Physics, University of Toronto

ABOUT two years ago, a detailed study of the thermal history of the Earth was begun at the University of Toronto. First results of this investigation have been presented at several meetings[1]. It should be emphasized that this study does not pretend to have determined the temperature and heat-flow at different times and depths within the *actual* Earth, nor has it included every possible physical mechanism which may have played a part in the Earth's thermal regime. What has been determined is a method of calculating the temperature and heat-flow at a number of times in the past and at depths within a particular type of Earth model, namely, that of an Earth cooling by conduction alone, and in which the radioactive substances are distributed in concentric shells of uniform concentration. A number of Earth models of this type have been investigated covering a wide range of possible Earth structures and evolutions.

Briefly, what has been done is that the equation of heat conduction for a radioactive Earth has been solved with the aid of FERUT, the electronic computer at the University of Toronto. Details of the computation have been given elsewhere[2]. It is easy to show that the problem can be broken into two parts: the cooling of the Earth from its initial temperature, and the heating up of the Earth due to radioactivity.

The initial temperature depends, of course, on the origin of the Earth. Broadly speaking, there are two schools of thought: those that postulate a hot origin and those that postulate a cold origin. If the Earth had a hot origin, its thermal history may be traced from the time of solidification, the initial temperature being close to the melting point. If the Earth was formed by the cold accretion of dust particles, then, quite apart from radioactivity, it would heat up due to compression, although it may not have become completely molten. Fig. 1 shows four initial temperature curves that have been considered: (I) the melting point curve due to Bullard[3], with a temperature at the centre of the Earth of about 8,000° C.; (II) the melting point curve due to Uffen[4], with a temperature at the centre of the Earth of about 5,500° C.; (III) the melting point curve due to Jacobs[5], with a temperature at the centre of the Earth of about 4,500° C.; (IV) a temperature distribution due to a cold origin. If the heating effects of compression, the formation of an iron core, etc., raised the temperature to the melting point, cases I, II or III would apply. If these effects were not large, it is plausible that there would not be much variation of temperature with depth, and a constant value of 1,000° C. has arbitrarily been chosen. Variations from this value can easily be allowed for.

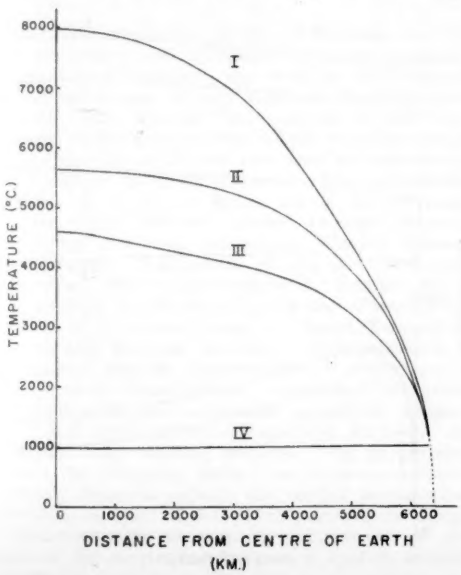

Fig. 1. Initial distribution of temperature

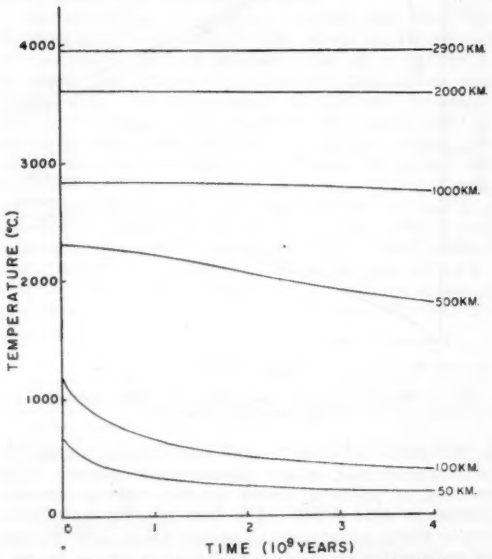

Fig. 2. Temperature–time distribution at various depths for a non-radioactive Earth (Model III)

Very similar features appear in the cooling of the Earth from any one of these initial temperature distributions. Fig. 2, which is for Model III, is representative of all four cases, and demonstrates how slowly temperatures change at great depths. At these depths thermal conditions are not greatly different from their initial values. Near the surface, on the other hand, cooling is considerable, and the surface heat-flow after four thousand million years is but little affected by the values taken for the initial temperature distribution in the first few tens of kilometres.

The second part of the problem, the heating of the Earth due to radioactivity, is far more complex, and

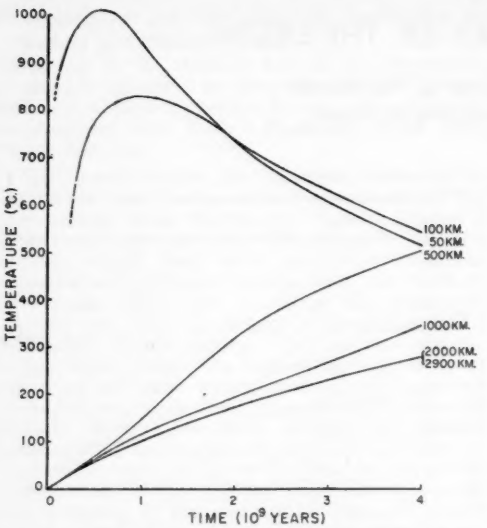

Fig. 3. Temperature–time distribution at various depths for a radioactive Earth (Model *B*)

a complete solution would have been impossible without the aid of an electronic computer. The method of solution allows for any desired concentration in nine shells. It is thus possible to approximate fairly accurately to quite varied distributions of radioactivity.

Four models have so far been investigated, all with the time at which cooling by conduction began taken as four thousand million years. This may be slightly low, since the age of the Earth is now generally believed to be about 4½ thousand million years[6]. However, an increase of 500 million years would not change the general behaviour of the various models considered.

Model *A* is a simplified one, and does not attempt to fit the details of crustal structure. This simplified model consists of three shells: a thin crustal layer 20 km. thick of granite–granodiorite composition, a uniform mantle of dunite, and a dense core of the composition of iron meteorites. Apart from the simplified crustal layer, this model is identical with one proposed by Bullen. Model *B*, originally due to Adams and Williamson, is considerably more detailed. A structure of four 15-km. layers is taken for the crust, with the top layer of granite–granodiorite composition, and the remaining three layers of composition changing from acidic to basic. From 60 to 1,600 km. the material of the mantle is identified as dunite and from 1,600 to 3,000 km. it is taken as of the same composition as pallasitic meteorites. The core is again identified with iron meteorites. The temperatures at different depths in the Earth at different times in the past for this model are shown in Fig. 3. It can be seen that at depth there is a continual increase in temperature, whereas near the surface, after a very rapid rise, the temperature begins to decrease with time. Model *C* is a modification of Model *B*, reducing the radioactivity in the surface layers. For this model a structure of two 15-km. layers is taken for the crust, instead of the four of Model *B*. Thus the layer of dunite extends from 30 km. to 1,600 km. Finally, for the sake of comparison, Model *D* was constructed, which allows for a uniform distribution of radioactivity. Although the same continual increase in temperature at depth with time occurs, the rapid rise followed by a decrease near the surface is absent in this case. Instead, near the surface, temperatures gradually increase with time, but at a much slower rate than at depth. This is due, of course, to the removal of the high concentration of radioactivity in the crustal layers, which is a feature of the other models. It should be noted that the identification of the Earth's mantle with chondritic meteorites is now thoroughly discredited[7], and no model with the relatively high concentrations which such an identification would entail has been considered.

The complete thermal picture of the Earth requires adding the cooling of the Earth from its initial temperature to the heating up of the Earth by radioactivity, that is, combining any of the four models I, II, III or IV with any of the four models *A*, *B*, *C* or *D*. This allows for sixteen possible combinations, and it is not practicable to reproduce them all here. However, many similarities between the models exist. Fig. 4 gives the temperature distribution for Model III *B*, which is representative of a hot origin of the Earth. In spite of the extremely low concentrations of radioactivity in the deep mantle and core, there is still a heating up there of two or three hundred degrees. Near the surface, conditions appear to have been greatly different in the far past from those existing at present—in fact, there may even have been remelting of material near the surface (down to about 100 km.) during the first thousand million years or so. If so, this could explain the now fairly well established fact that the Earth as a whole is about 4½ thousand million years old[6], whereas no rocks have been found much older than about three thousand million years. (A similar suggestion was made by W. D. Urry some years ago[8].) However, this brief temperature rise at the beginning soon ceased and cooling commenced. The rate of cooling was greater in the past than it is now, and this suggests that orogenetic activity may have decreased

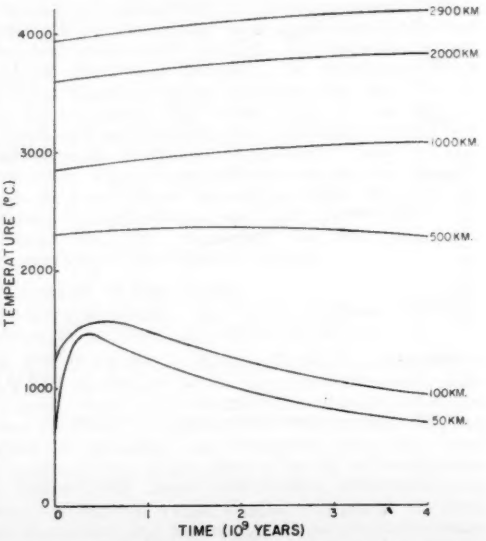

Fig. 4. Temperature–time distribution at various depths within the Earth (Model III *B*)

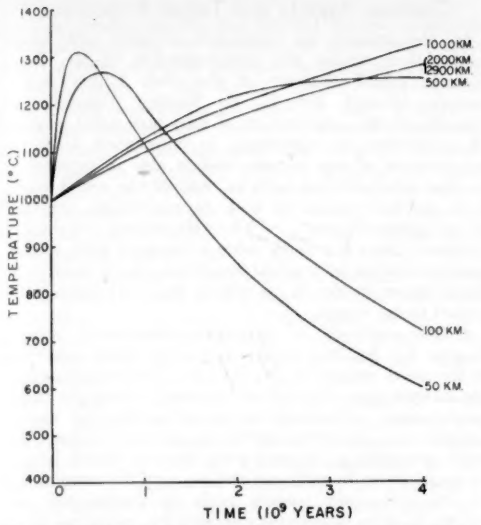

Fig. 5. Temperature-time distribution at various depths within the Earth (Model IV *B*)

with time, and perhaps have been caused by different processes in the far past. The present temperatures at depths of 50–100 km. differ by as much as 200° C. between Models III *A* and III *B*. These models are representative of conditions beneath the oceans and continents, and such a temperature difference may well exist and have an important bearing on orogenesis. Fig. 5 gives the temperature distribution for Model IV *B*—an Earth with a cold origin. Here the thermal history is very dependent on the value assumed for the constant initial temperature. As shown in Fig. 5, if this is taken as 1,000° C., there is heating at depth and an initial temperature rise near the surface, as before. For a value of 2,000° C., there is no initial rise near the surface.

In conclusion, two points stand out from the investigation so far carried out. First, all the models of the Earth studied indicate that the temperature at depth has continued to increase throughout geological time, the temperature at the core boundary having increased most probably by about 300° C. Secondly, although radioactivity plays a major part in the thermal history of the Earth, the initial distribution of temperature dominates thermal conditions at depth and near the surface for the first thousand million years or so. The cosmological questions involved in the origin of the Earth cannot unfortunately be shelved. The discovery of radioactivity, although helping to solve many geophysical problems, cannot in itself wholly explain the Earth's thermal regime.

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[4] Uffen, R. J., *Trans. Amer. Geophys. Union*, **33**, 893 (1952).
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PRODUCTION AND UTILIZATION OF ELECTROMAGNETICALLY ENRICHED ISOTOPES

DURING September 13–16 a conference on "The Production and Utilization of Electromagnetically Enriched Isotopes" was held in the Cockcroft Hall at the Atomic Energy Research Establishment, Harwell. This was the first meeting to have been arranged on the subject since details were declassified of the calutrons which are now used for enrichment of the isotopes of all the elements. The meeting was attended by Dr. C. P. Keim, Dr. C. E. Normand, and Mr. Boyd Weaver (Stable Isotope Division, Oak Ridge National Laboratory, United States); representatives of separator groups at Copenhagen, Amsterdam, Paris (Commissariat à l'Énergie Atomique, Saclay), Stockholm, Upsala and Gothenburg; members of interested groups in Egypt, Yugoslavia, Belgium and Western Germany; representatives of the nuclear physics departments of a number of universities in Great Britain; members of the group concerned with electromagnetic separation at Harwell; and other interested research workers. An unusually lively meeting resulted. The programme covered the following fields: ion sources, collector problems, chemical aspects and target preparation, utilization, analysis of isotopic abundance, the design of electromagnetic separators, and the use of the separator for active materials as a tool in nuclear research.

The conference was particularly concerned with the stable isotopes other than those of the elements hydrogen, carbon, nitrogen and oxygen, which are enriched by other methods and the application of which has been abundantly dealt with in a variety of reviews. Mr. D. W. Fry, chief physicist of the Atomic Energy Research Establishment, welcomed the delegates and briefly reviewed the twenty-eight papers to be given.

Ion Sources

At the session on ion sources, held under the chairmanship of Dr. P. C. Thonemann (Harwell), the first paper was by Dr. Normand, of the Oak Ridge separator project, who described the ion sources used in the calutrons. At first the ion source at Oak Ridge was heated by resistance-type (calrod) heaters embedded in the cast-copper charge oven and arc-chamber support block. The service temperature-limit for heaters of this type restricted the operating temperature to about 700° C. or less, even when the casting of the charge oven was surrounded by stainless-steel heat shielding. The substitution of graphite components for the copper source castings, and of graphite strip heaters for the embedded calrod heaters, resulted in a source capable of operating at

regulated temperatures up to approximately 1,000° C. In order to vaporize metals of the platinum and palladium groups directly into the ionizing arc, a third type of source was developed in which heating was by means of high-energy electron bombardment.

Prof. J. Kistemaker then described the ion sources of the Amsterdam separator, which is a 180° machine having an ion output of up to 10 m.amp. In particular, he gave a description of the five types of breakdown of the high voltage used in the acceleration of the positive ions from the ion source. Mr. O. E. G. Almén described developments of ion sources in Scandinavia. At present the magnetic type is used exclusively, with the magnetic field either parallel with, or perpendicular to, the direction of the extracted ion beam. A feature of the Copenhagen source is the use of a vacuum lock for the introduction of the source material so that separation can be made with very short-lived isotopes.

Great interest was aroused by the description, by Dr. R. Bernas (Paris), of a new sputtering-type ion source suitable for the elements of low vapour pressure. In this method the element is sputtered into the arc chamber using a primary argon discharge. This source is still under development, but is extremely versatile and has valuable possibilities for the separation of radioactive elements produced, for example, by bombarding a foil in an accelerator. Dr. R. H. Dawton then reviewed experimental work at Harwell during the past few years on a number of ion sources, including filament sources, radio-frequency types, a sputtering type, a Kunsman source, and sources depending on thermal ionization. Some of these sources have been realized in practice and are being used with the new sector separator recently constructed at Harwell.

Collector Problems

For the second session, on collector problems, Dr. J. Koch (Copenhagen) was in the chair, and the proceedings opened with a description by Dr. Normand of the unit used for collecting heavy ion beams at Oak Ridge. These beams may amount to more than 100 m.amp. at 30 kV., and the difficulties were concerned with the space available as well as the problems of dealing with the energy dissipation and collector erosion. The special constructions which are used to minimize losses by evaporation and sputtering were described and also the arrangements used to prevent cross-contamination of isotopes. A more detailed description was given of the refrigeration system necessary for mercury collection, and of the special collector arrangements. Dr. M. L. Smith then dealt with experience at Harwell in the same problem, discussing particularly the chemical contamination of isotopes. He also described arrangements suitable for the collection of the very volatile elements such as sulphur and chlorine, the gases oxygen and nitrogen, and the rare gases.

The problem of the collection of mercury was returned to by Dr. Ranc (Saclay atomic energy group), in whose system the source is supplied with mercury vapour while collection is achieved on gold foil cooled with liquid nitrogen. To obviate contamination from the mercury vapour existing in the tank at room temperature, a secondary liquid-air trap is placed near the source and provided with a slit, so that only the directed mercury ions can pass.

Chemical Aspects and Target Preparation

In the session on chemical aspects and target preparation, under the chairmanship of Mr. Boyd Weaver (chief chemist of the Oak Ridge Stable Isotope Group), Dr. K. O. Neilsen (Copenhagen) considered the penetration of ions into solid lattices. This problem is important in connexion with the preparation of gas targets and is also of interest to several other studies such as that of the recoil atoms from nuclear reactions and, in particular, the field of radiation damage. The theoretical conclusions obtained from his work were compared with experimental studies by nuclear reactions which enable the distribution in depth to which the ions have penetrated to be found.

Other methods of preparing separated isotopic targets for nuclear reaction studies were described in the next paper by Dr. Smith. He commented on the advantages of a central station for isotopic target preparation, considered the requirements for nuclear targets and described some typical techniques. The most versatile is vacuum evaporation, which besides its application to salts can also be used for evaporation of the refractory metals such as magnesium and silicon to give elemental deposits by using tantalum filaments as a source on which the oxide is reduced. This method can also be used for the preparation of metallic targets of the alkali and alkaline-earth metals, and special handling techniques were described by Dr. Smith for these. Direct deposition in the separator is used for various gases and for boron, which stays down with less than 10 per cent sputtering on a variety of metallic backings.

Mr. Boyd Weaver then described in some detail chemical aspects of the work on electromagnetic separation, dealing first with the preparation of charge materials. So far, more than fifty elements have been separated, and in most cases some special chemical operations have been necessary or helpful in the supplying of suitable charge materials for the separators. Whenever possible, a variety of forms of each element has been prepared in order to make comparisons between halides, oxides and elements. Improvements in operating efficiency have been attained by applications of such techniques as vacuum dehydration and pelletizing. Half the elements still unseparated consist of the rarer rare earths. In order to make as much as a kilogram of each of these available, various methods of separation have been explored. Separation by continuous counter-current extraction between nitric acid and tributyl phosphate has been developed and applied to the preparation of unusual quantities of these elements.

Turning to the processing of the enriched material in the collectors, Mr. Weaver pointed out that these are always contaminated by a large number of other elements which have to be removed in order to obtain the pure material needed for nuclear research. The purifications require an unusual type of quantitative analytical chemistry, in which the emphasis is on separation rather than on measurement of quantities. Purification schemes suitable for quantities from milligrams to grams have been developed for each of the elements.

Applications of Electromagnetically Enriched Isotopes

In this session the chairman, Dr. Keim, gave a wide-ranging review of the achievements of the stable-

isotopes programme in the United States, which, so far, has involved the dispatch of more than 2,600 consignments of stable isotopes to users in sponsored establishments of the Atomic Energy Commission, government agencies, universities and industries. Dr. Keim pointed out, however, that the contributions which stable isotopes are making to basic science and in a growing number of practical applications are not widely appreciated. This is largely because stable isotopes are at present of greatest value to the research physicist in fundamental investigations which receive little publicity. There is also a reluctance to use enriched samples, as they appear to be expensive, although, in fact, only small quantities may be needed, while other savings may justify their use. They are, too, more difficult to use than radioisotopes, but improvements in mass-spectrometry techniques will help here.

Dr. Keim quoted the immense range of work already published and went on to describe a few particular applications of stable isotopes. These included: their use as starting materials in the assignment of masses to artificially produced radioisotopes and in investigations of their disintegrations; the determination of neutron absorption, scattering, and total cross-sections at all neutron energies; atomic spectroscopy, especially in the study of hyperfine spectra, isotope shifts, nuclear spins, etc.; the determination of nuclear energy-levels, and studies of isomerism; superconductivity, self-diffusion, coefficients of expansion and other solid-physics studies; β-spectroscopy using enriched isotopes like potassium-40 and beryllium-10; use for pile and cyclotron bombardments to produce radioisotopes of high purity and high specific activity, and to produce certain isotopes otherwise unavailable at a reasonable cost; use as tracers in isotope-dilution analysis, a technique which is now being increasingly applied in geology, agriculture, metallurgy and biology.

Dr. W. D. Allen (Nuclear Physics Division, Harwell) then described the investigations which have been carried out with materials supplied by the separator group at Harwell. He illustrated his lecture by details of a few particular investigations out of many which have been carried out during the past five years using the six hundred and fifty consignments which have so far been dispatched by Harwell to users in many countries. Dr. Allen first described reaction studies with the van de Graaff and Cockcroft–Walton machines and then gave a detailed review of a variety of studies using neutrons, describing, in particular, the current work on fast-neutron capture in the Zephyr reactor. This work refines the earlier studies by D. J. Hughes of the variation of cross-section with atomic weight which has some cosmological implications and also throws more light on the magic-number nuclei.

Dr. Allen considered a variety of other topics, including β-ray studies; (n,p) reactions using 14-MeV. neutrons; several other reaction studies; and photo-disintegration. In a forecast of future work with electromagnetically enriched isotopes he said that the work on neutron cross-sections in all energy-ranges is only just beginning. Studies in Coulomb excitation show much promise; the work with 1-MeV. high-tension sets in many universities will continue and will gradually extend to the masses in the range oxygen-16 to calcium-40. He also mentioned tritium and helium-3 reactions and the very interesting subject of double β-decay.

Dr. J. C. Kluyver (University of Utrecht) then described the investigations he has been making on (p,γ) reactions using enriched isotopic targets of magnesium and silicon. It is imperative to use enriched targets for this study in order to assign correctly each proton-capture resonance. With a non-separated target, this assignment is very difficult as aluminium-25 and -26 have nearly equal half-lives, and the long-lived aluminium-26 may easily be confused with the stable aluminium-27 as product nucleus. As natural magnesium contains 79, 10 and 11 per cent of the isotopes of weight 24, 25 and 26, respectively, isotopic targets of magnesium-25 and -26 are nearly tenfold enriched, and a corresponding gain in the γ-ray yield is obtained. Also, the analysis of the weak ^{25}Mg (p,γ) resonances is greatly facilitated by the reduction in the intensities of the forty-times stronger ^{26}Mg (p,γ) resonances in their neighbourhood. From this work the energy-level schemes of aluminium-26 have been worked out. The use of isotopic targets of other elements in (p,γ) reactions will have similar advantages.

Dr. H. G. Kuhn (University of Oxford) then gave a polished account of applications in spectroscopy and in solid physics. He said that the differences in the masses of isotopes give rise to vibrational and rotational isotope effects in molecular spectra. Their study, either by optical or microwave methods, can be an important aid in the analysis of spectra. In atomic spectra the mass effect is predominant in the lighter elements, and its study is necessary for isolating the more important 'volume effects'.

A great variety of interesting spectroscopic effects are caused by differences, between the different isotopes, of their values of nuclear spin (I), magnetic moment (μ), electric quadrupole moment (Q) and distribution of charge inside the nucleus. Investigations of these effects are often very difficult, and sometimes impossible, unless highly enriched isotope samples are available. Light sources containing certain pure or highly enriched isotopes can produce very highly monochromatic light. This property makes them suitable for use as wave-length standards, for interferometric measurements of gauges of great length and for purposes of adjustment of interferometers of long path.

Most properties of solids depend on the atomic masses, and the study of isotope effects can be a powerful means of testing the validity of theories. Such effects are usually small and difficult to measure, but some variable results on the transition points of supraconductivity and on the rate of change of electrical resistance of metals with temperature have already been obtained. Apart from their bearing on the theories of conduction and supraconductivity, results of this kind are likely to contribute generally to the knowledge of the structure of solids.

Isotopic Abundance Analysis

The session on isotopic abundance analysis, with Prof. J. H. E. Mattauch (Max-Planck Institut für Chemie, Mainz) in the chair, was one of the most vigorous of the conference. It opened with an account by Dr. Keim of work at Oak Ridge, where the mass-spectrometry section is concerned with analysis of samples from the separator group and also with a variety of research problems in collaboration with many institutions. During the past few years the tendency has been to move to techniques for the less-volatile elements requiring high source-temperatures, and so special furnace

and thermal ionization methods have been especially developed. Techniques of small-sample loading employing micro-pipettes and a microscope were described, and the advantages and problems of working with extremely small samples of a few micrograms were discussed. Details were given of a range of instruments developed in the group, including one made by the General Electric Corporation. Mr. G. H. Palmer then described the work at Harwell in this field. He said that, as in Oak Ridge, the emphasis has been on handling solid samples rather than gases, and described the precautions necessary for this kind of work. In particular, he discussed the difficulties of quickly comparing samples and obtaining ion beams of constant intensity. He then described a new mass spectrometer which has been developed at Harwell, in association with Metropolitan-Vickers Co., Ltd., especially for solid analysis and which incorporates both furnace and triple-filament assembly types of sources together with a variety of detection devices. In a selective review of Harwell work, he described results obtained with lithium, lead and uranium. Mr. Palmer then went on to read a paper by Prof. G. D. L. Schreiner and Dr. R. T. Jamieson (Johannesburg) on age determination by isotopic-dilution techniques. This was a valuable and detailed discussion of the theoretical basis and the errors in the technique, with particular emphasis on the rubidium–strontium method.

Among the papers at this session was a notable contribution by Dr. H. Hinterberger (Mainz). He first dealt with the principles and mass-spectrometric techniques used in isotopic-dilution methods, and then went on to survey work in this field. After a discussion of the potassium–argon method used in the determination of the age of the Earth, he described his own recent contribution with the newly developed rhenium–osmium method. This very interesting work is probably a unique example of the success of mass spectrometry over the counting methods.

The last paper of the session, by Dr. A. H. Gillieson (Chemistry Division, Harwell), discussed methods other than mass spectrometry by which measurements may be made of isotopic abundance. The methods dealt with can be briefly listed as: neutron source methods (neutron absorption, radioactivation); optical methods (emission spectroscopy, absorption spectroscopy, refractive index); and mass methods (density). Evidently there are several alternatives to mass spectrometry which should be considered in practical problems.

Design of Electromagnetic Separators

This session, with Prof. Kistemaker in the chair, brought excellent papers from three leading workers in the field, the first being Dr. Normand, who gave a detailed and beautifully illustrated review of the Oak Ridge plant with technical details of the installation. The present equipment includes two small and two large calutrons which are operated for seven days a week on three shifts, and it is being planned to extend the facilities by adding two more large calutrons shortly.

Dr. Dawton then discussed the design considerations which led to the construction of the new high-resolution separator at Harwell. This machine, which is intended for enrichment of the isotopes of the transuranic elements and of fission products where high activities may be encountered, is a 4-ft. radius, 90° separator of the Nier type and is as fully automatic as possible. A detailed description was given of the remote-handling device for removal of the collectors containing the enriched product without exposure to air. Recent experimental results on the properties of plutonium of particular importance to its electromagnetic separation were also described.

Dr. Koch gave a masterly review of the Scandinavian separators in which, speaking for the groups in the three Swedish laboratories as well as for his own laboratory at Copenhagen, he described all four instruments. These separators have much in common, and a best basic design for use in nuclear studies has clearly been developed by these workers during the past fifteen years. The application to research on short-lived isotopes by integrating the separator with other tools such as the cyclotron and β-ray spectrometer to make a unified assembly which can attack most powerfully nuclear problems of all types was demonstrated. Dr. Koch concluded by making a plea for the preparation of the widest variety of stable and radioactive isotopes in the state of highest purity.

Two papers were presented to the conference at the last moment, and these fitted best with the session on design. The first was a theoretical paper by Dr. H. Bruck (Saclay), who showed that, for a magnetic separator of the usual sector type, the use of the alternating gradient principle in magnet design instead of the usual arrangement of a uniform magnetic field so far employed gives greater dispersion. In effect, one can have higher dispersion for the same radius, or the same dispersion for a smaller radius. The last paper was a possibly prophetic contribution beautifully presented by Dr. O. Osberghaus on the use of alternating-gradient electrical focusing for mass separation. In this system, using an arrangement very similar to that used on high-energy machines for beam ducting, a direct-current and radio-frequency voltage are applied to alternate plates. An experimental unit using this system has been successfully run at Bonn, and a larger one is now being constructed. This device is limited to small ion beams because of the lack of space-charge stabilization, but it seems that the principle may be useful for beams of up to 100 μamp. Dr. Osberghaus, who is working with Prof. W. Paul at Bonn, envisages two systems, one in which a selected mass is passed alone and the other in which a selected mass can be rejected.

Separation of Active Material

The last session, under the chairmanship of Dr. Bernas, consisted of two papers, though the earlier paper by Dr. Koch had, in fact, largely dealt with the same subject. Dr. G. Andersson reviewed nuclear studies in Scandinavia carried out with electromagnetically enriched radioisotopes. He described first the use of the separator for the preparation of samples of known masses for beta-ray spectroscopy and, in particular, for work on the rare-gas isotopes which are studied after trapping in foils. Extensive work on the radioactive nuclides of krypton and xenon has been done at Stockholm by this technique.

Dr. Bernas then dealt with his work at Saclay, where he has constructed a medium-sized separator particularly suitable for the elements of light and medium mass. This instrument can separate tens of milligrams of a given element in a day, while being sufficiently flexible to separate in rapid succession

the radioactive isotopes of widely differing elements. Actual experience with this instrument has shown that both modes of operation are possible and successful; they provide alternative experimental approaches to the particular problems, and Dr. Bernas discussed their relative merits. He also described in some detail the work on technetium, which is prepared by cyclotron irradiation of a molybdenum target and then mass-separated. An interesting example of the application of the separator to alpha-particle spectroscopy was also described.

A lively discussion followed every paper, and it was felt that the conference had had some important results in directing attention to a great variety of applications of mass spectroscopy, and in describing many applications of electromagnetically enriched isotopes. Hitherto, the more spectacular application of radioisotopes and the relative ease of their techniques of use has overshadowed the uses of stable isotopes. It was felt that the present conference would show the rich field of work still waiting to be done in the latter field. In summing up, one might say that three main types of activity could be clearly recognized at the conference: the work of the two groups at Oak Ridge and Harwell in the provision of enriched isotopes for basic research of all kinds; the work of several European groups in the application of medium-sized isotope mass-separators to the direct study of a great range of nuclear problems; and lastly the large numbers of research workers who essentially are applying the enriched isotopes provided by Oak Ridge and Harwell to a great variety of researches. An important result of the conference was that the common interests of these groups were clearly recognized and great stimulus given to their work. It is hoped that on publication of the proceedings a much fuller appreciation of this new field will be generally gained. The proceedings, including lectures, discussion and illustrations, will be published shortly by Butterworths Scientific Publications, Ltd., London.

M. L. SMITH

MANAGEMENT AND HUMAN RELATIONS

AN attendance of nine hundred members at the annual conference of the Institute of Personnel Management at Harrogate during October 7–9 is an indication of the growing importance attached to the personnel function of management in British industry. Those attending came from very large and small manufacturing firms, departmental stores, nationalized industries, public corporations, insurance and other commercial concerns, educational institutions and the Armed Forces. A number came from overseas. At the plenary sessions speeches of a high order were given, and at the various sectional meetings the investigations now being made into the behaviour of people in industry by a number of research organizations were discussed.

Sir John Hunt, leader of the British Mount Everest Expedition in 1953, opened the conference with a challenging paper on the needs of youth in a Welfare State. There are, he said, many signs that the spirit of young people is either flagging or misdirected; there is too much apathy and hooliganism abroad. A great deal of fine work is still being done to help young people find their feet and set them on the road to good citizenship, and yet it would be foolish to be complacent and suppose that more could not and should not be done. Something is lacking in the opportunities offered, in the guidance given: What is this lack? First, the incentive to achievement is generally inadequate. If it is accepted that one of the needs in every individual is a sense of purpose, then the opportunity of achievement is an essential step in providing that purpose. Secondly, there is a great need for leaders, both in numbers and in quality. The paid official alone will not do, and the need is for more volunteers, because they bring to young people a variety of experience of contemporary life. Ideally, leaders should have graduated from a similar background to members of the group—the best leadership is leadership from within the group, not from above it. The main source of youth leaders should be ex-members of the organizations themselves rather than older men implanted from outside and from a different environment.

A scheme should be devised which embodies incentives and sets certain targets or standards of achievement. How can such a scheme be made attractive and how can it work? Can a scheme of wide application be devised which might draw in more young people? Sir John suggested that it should be planned under four headings: the development of a hobby—a technical, scientific or artistic skill; the development of physical fitness—this calls for moral as well as physical stamina; outings, whether on foot or cycle or in a small boat—these are of tremendous value to the character training of young people and can be extended progressively until they assume the character of expeditions; and the instilling of the spirit of service—this is best caught by example, and the example must come from the leader.

Sir John was followed by Sir Richard Coppock, general secretary of the National Federation of Building Trade Operatives, who said that, in the main, the weakness of the building industry is on the managerial plane. He was particularly concerned about the missed opportunities for consultation between management and worker. The experience the workers possess is the basis of Britain's prosperity and is unequalled in any board-room in the country. Things do not go wrong on the drawing-board, he maintained, but when machines are being run and built, and he quoted the Comet aircraft as a good example of this. Half the difficulties in his industry arise because the employer does not enlist the goodwill of his men by telling them all the facts. The great problem facing management is how to handle men. One of the most vicious things they can do, when an unofficial strike takes place over some petty tyranny, is to say: "You must all go back at once. We cannot see you". This, said Sir Richard, puts the trade-union official in a most humiliating position—he is humiliated before negotiations have even begun.

Some management problems in the British Broadcasting Corporation were discussed by the director-general, Sir Ian Jacob. The Corporation employs

13,823 men and women, made up of 3,230 monthly paid staff, 3,950 secretarial and clerical staff and 3,643 manual staff. They belong to some fifty nationalities and more than a hundred professions which, with the wide geographical spread, create peculiar problems. The executive management is carried out by a board which consists of the director-general and six other directors. The directors of Sound Broadcasting, Television and External Services have purely functional duties, that is, they are responsible for a field of output and for the staff directly concerned with that output. The director of administration and the director of technical services have responsibilities which permeate the whole Corporation, though each has a considerable direct area of responsibility in addition. The sixth director is the chief staff officer to the director-general on policy matters.

The Corporation has no criterion of profit by which to test the success of the methods employed by its various parts, and it must therefore endeavour to regulate administration by giving to directorates the guidance emanating from specialist departments that are centrally established. One of these is the Central Establishment Office, which continuously investigates, in close co-operation with the heads of the departments concerned, staffing, organization and methods. Between two and three hundred technical assistants are recruited for the engineering staff each year, while for the programme and administrative staff a small number of young men and women are recruited straight from school or from university, though the majority enter at a later stage. The main need with regard to staff is for people who have attained a certain degree of experience and skill in the world and who enter the Corporation in response to public advertisement.

In such a diverse and dispersed body as the Corporation, a system is necessary which enables people to move easily from one compartment to another, for otherwise promotions would tend to remain within departments and a general rigidity would ensue. This problem is solved by a promotion system affecting the whole organization, a flexible grading system, and a scheme of bonuses for outstanding work and creative skill. Such a large organization gives rise to considerable problems of communication, but these are minimized by regular meetings up and down the chain of command and staff representation. Considerable staffing difficulties have been caused by the formation of the Independent Television Authority, and drastic measures have been used to deal with them. With the ending of the Corporation's solitary position in the country, broadcasting, and television in particular, are now moving into a new phase in Great Britain.

The development of research into the human factor in industry was outlined by Mr. A. B. Waring, chairman of Joseph Lucas (Industries), Ltd. This had, in 1953, led to the setting up of the Joint Committee on Human Relations in Industry, with himself as chairman, to advise the Department of Scientific and Industrial Research and the Medical Research Council on research in this field. The majority of the projects it has accepted fall under four broad headings: incentive schemes with reference to the social factors associated with them; technological change with reference to the human implications involved; management organization with reference to staff supervision and functional specialists; promotion and training. There are also special projects such as relations between office staffs and factory workers and the effects of ageing on adaptability to work.

It is possible, he said, to approach the subject of human relations in industry from a basic theory that any community left to its own devices will establish for itself in the course of time a *modus vivendi* which will satisfy the majority of its members so that the pattern of relationships among them and their general contentment will remain more-or-less constant. But when violent changes are imposed by wars, the impact of other civilizations or the upheavals due to the changes that industrialization brings about, the pattern of society becomes distorted and discord ensues. Changes in the pattern of work and employment brought about by changes in the circumstances of trade and by ever-increasing mechanization can result in disturbances ranging from suppressed resentment to open resistance. Man, being a reasoning animal, is prepared to accept change when it is properly presented and when he is satisfied that he will benefit or that his future depends on it.

The best human relations will exist in those factories in which leadership qualities are high and well founded and are regarded as being no less important than technical and administrative ability, and where both leaders and led work in circumstances that maintain continuously both their status and their morale. Mr. Waring suggested that before any project of research into human relations in industry is undertaken, it should first pass the test of whether or not it falls into the category of a deeply rooted problem of general significance; if not, and if it can be classified as a problem resulting from inadequate local management, it is unlikely to be a subject for basic research and may well be dealt with through management training and reorganization or through investigation by industrial consultants. But where, in a branch of industry, there is a general malaise evidenced by labour unrest with no apparent sensible justification, or where in specific instances the support of workpeople is withheld or there is either open or suppressed resistance the reasons for which are obscure, research is the obvious and perhaps most valuable method of approach.

Mr. Waring stressed the importance of choosing subjects for research in human relations most carefully; otherwise there is the danger of regarding such research as a type of industrial patent medicine. It is equally important that its practitioners should be worthy of their tasks. T. H. Hawkins

OBITUARIES

Sir Malcolm Watson

Sir Malcolm Watson, director during 1933–42 of the Ross Institute of Tropical Hygiene (London School of Hygiene and Tropical Medicine), died on December 28 at the age of eighty-two.

The successive steps which led to modern conceptions of the epidemiology of malaria were: (1) Manson's hypothesis that mosquitoes transmit the disease; (2) Ross's confirmation that mosquitoes do transmit, and his own, most important, contribution showing that not all of them do so—not the grey mosquito, not the brindled mosquito, only the dapple-winged one; (3) Grassi's entomological addition that the mosquitoes which transmit malaria

all belong to the genus *Anopheles*; and, finally, (4) Stephens and Christophers', and James's, fundamental rules: (*a*) some species only of the genus *Anopheles* are of practical importance in malaria transmission, and (*b*) each of them has its own preferential breeding places.

Malaria control, as an activity directed against mosquitoes, had taken no account of these rules, which I have called fundamental because they became, in Watson's hands, the basis of antilarval measures. Anti-mosquito work, in the early days, consisted of measures directed against the breeding places of mosquitoes, irrespective of their genus or species. As often as not more larvæ were killed belonging to the genera *Culex* or *Aedes* than to *Anopheles*. The waste of effort was compensated, to some extent, by the fact that the earlier successful campaigns were directed against urban malaria (Ismailia, Havana, Port Swettenham), with the advantage of the population to be protected living within a comparatively small area.

That was Watson's experience in Malaya. He had successfully dealt with the malaria epidemic in Port Swettenham, the newly opened maritime port of the rubber-growing districts, which threatened to become useless because of malaria. Watson saved it from being closed again; but he was at a loss how to act when he was requested to apply his method to the rural areas where rubber was grown, and where the labourers employed on the estates were seriously affected by endemic malaria. It was clearly impossible to remove, or to oil, all breeding places of mosquitoes in a large rural area, as had been done in a small urban area: the expense would have been prohibitive.

At this juncture Watson remembered the Stephens–Christophers–James rules, and the way they had been established. He applied his predecessors' method of research, which has become the pattern of the so-called malaria survey: the preliminary stage of every anti-malaria campaign. This survey includes two main sections. The first consists of three parts: (1) determining the distribution of malaria in the district; (2) collecting adult anopheles and identifying them, so as to be able to compile a list of the anopheline species of the district, and to establish the distribution of each one of these species; (3) comparing the data afforded by (1) and (2), in order to find out whether or not a correlation can be established between the distribution of malaria and of one of the local anopheline species. If such a correlation exists, the species involved is suspect of being the local vector of malaria. The second section of the survey consists of two parts: (1) determining the natural rate of infection with malaria parasites of each one of the local anopheles, in order to check the results obtained in the first section; (2) identifying the principal breeding places of each anopheline species. When the principal local vector has been identified in this way, and it has been proved, moreover, that this species has more or less specialized breeding habits, which induce it to select a certain type of breeding place in preference to all others, it becomes possible successfully to suppress the breeding of that one species, by dealing with its preferential breeding places, while leaving undisturbed all other collections of water, and the larvæ of the species breeding therein. This method of selective larval control, which since then has been called 'species sanitation', was first elaborated by Watson on the rubber estates in the flat swampy land of the coastal area of western Malaya, where *Anopheles umbrosus* was proved to be the main vector, and next in the hilly country, where *Anopheles maculatus* takes over this function. It proved much less expensive than the indiscriminate larval control applied in cities, and so it rendered possible "rural sanitation in the tropics", the highly appropriate title selected by Watson for his first book.

Watson's method of species sanitation has conferred untold benefits on many countries to which it was applied, notably on the former Dutch East Indies (now Indonesia). So it is not inappropriate that the editors of *Nature* should have invited a Dutchman to pay posthumous homage to this benefactor of humanity.

N. H. Swellengrebel

Dr. V. E. Nash-Williams

Dr. V. E. Nash-Williams died suddenly at the age of fifty-eight on December 15. He had been keeper of archæology in the National Museum of Wales and lecturer in archæology (more recently head of the Department of Archæology) in the University College, Cardiff, since 1926. For those long years he had held two posts. The second, the teaching of archæology in the College, had, in recent years, expanded from a subsidiary to an honours course as a result of his work.

Dr. Nash-Williams's earliest excavations were a series made in the 'twenties and 'thirties on the Roman legionary fortress of Caerleon. Those which proved to be his last were on the civil settlement which he had long supposed to lie outside the fortress walls in an area still, by good fortune, not built over; the other legionary fortresses of Britain provide no similar opportunity. His suppositions were proved to be correct by his excavations of 1954 and 1955, excavations which he had hoped to continue for many years, for the area is a large one and the promises were good.

He had also conducted important excavations at the Roman town of Caerwent and on the Early Iron Age hill-forts at Llanmelin and Sudbrook in Monmouthshire, and on the monastic site and the Roman villa at Llantwit Major and the Roman auxiliary fort at Neath, in Glamorgan. The results of these and other works are to be found in publications of the National Museum of Wales, or in *Archaeologia*, *Archaeologia Cambrensis* and the *Bulletin of Celtic Studies*.

A field survey of the Roman military sites in Wales led in 1954 to his book "The Roman Frontier in Wales", an up-to-date review of the evidence of the Roman occupation, and a work now indispensable to any serious student of Roman Britain. A comprehensive inventory and survey of the more than four hundred early Christian crosses and monuments of Wales form the subject of his largest work, "The Early Christian Monuments of Wales", published in 1950. It is richly illustrated and does for Wales what Romilly Allen and Anderson's book did for Scotland. This work alone is a memorial of his industry and scholarship.

Dr. Nash-Williams believed that if archæology was to be a live subject, there must be active excavations on one hand, and on the other a continuous exposition of the results to the public. In this, as in other ways, his practice matched his principles. His untiring work in the field and in writing, teaching and lecturing caused his subject and his interests to be widely known, and they, and his personal qualities, made him greatly esteemed. He possessed humility

and a charm of manner and was a devout churchman. In each of the World Wars he served in the Army, in the first in the infantry and in the second in the R.A.S.C., from which he was seconded to the Historical Section (Military) War Cabinet Offices, for preparatory work on the official history of the War.

The archæological world has lost a mature and industrious scholar and we in the National Museum of Wales mourn the loss of a distinguished colleague and a friend. The deepest sympathy is extended to his widow, his sons and his mother.

D. Dilwyn John

Mr. P. Y. Millns

Peter Yorke Millns, a brilliant research student of astronomy in the University of Manchester, lost his life on the Aletsch Glacier near the summit of the Jungfrau in the Swiss Alps on December 19.

Peter Millns, who was twenty-two years of age, graduated in physics in the University of Manchester with first-class honours in June 1954. He then joined the Department of Astronomy of the University to do research in nebular photography with high-speed Schmidt cameras in monochromatic light. With the help of Dr. A. Burawoy, of the College of Technology, Manchester, Millns developed in a short time an important application of dye filters for astronomical photography, and his first contribution to this subject was presented at the Manchester symposium on astronomical optics held last April. Quest for transparent skies led him repeatedly to Europe's highest observatory at Sphinx, Jungfraujoch (3,576 m.), and there he met his untimely end in a mountaineering accident during leisure-time. The accident has deprived science and the University of Manchester of a brilliant young scientist and a well-liked colleague.

Zdeněk Kopal

NEWS and VIEWS

Archæology of the Roman Empire at Oxford: Prof. I. A. Richmond, F.B.A.

Next October there will come into existence in the University of Oxford a chair in the archæology of the Roman Empire, and Prof. I. A. Richmond, himself an Oxford graduate, has accepted an invitation to be its first occupant. Prof. Richmond, who is fifty-three, is at present professor of Roman–British history and archæology at King's College, Newcastle upon Tyne, where he has been for the past twenty years. He is a leading authority on Roman Britain, and has excavated in many widely separated places in England and Scotland. Most recently he has been engaged with Dr. J. K. St. Joseph at Inchtuthil in work not yet finished which will give a complete picture of an unaltered Flavian legionary fortress, the general headquarters of the governor Agricola. Prof. Richmond early in his career, in 1930, produced the standard work on the City Wall of Imperial Rome. His most recent book is the masterly history of Roman Britain published last year by Penguin Books, Ltd., which ends with an admirable twelve-page bibliography. Prof. Richmond is a Fellow of the British Academy and an honorary graduate of the University of Edinburgh; in May he is to receive an honorary degree from the University of Leeds. In the University of Durham he has served with distinction as dean of the Faculty of Arts and as Public Orator. He is widely known as a skilful lecturer of exceptional clarity of speech. Joined to his patient devotion to study and investigation are a warmth of human sympathy and gaiety of heart which will endear him, as it has endeared him to his many friends at Newcastle and elsewhere, to the society of All Souls College, Oxford, of which he will be a Fellow when he takes up his new professorship next autumn.

Nicholas Kulchitsky (1856–1925)

The eminent histologist, Nicholas Kulchitsky, was born at Kronstadt a hundred years ago, on January 30, and it is almost exactly thirty-one years since he met with the accident in London that led to his death at the age of sixty-nine. Kulchitsky was appointed to the chair of histology at Kharkov in 1893, retiring from it in 1910 in order that the younger members of his staff might have better opportunities for promotion. He held a number of appointments in Russia before the revolution of 1917, finally becoming Minister of Education. There followed a period of considerable hardship until he arrived in England in 1921. He joined the staff of the Anatomy Department at University College, London, on the invitation of Sir Grafton Elliot Smith, continuing to teach and to follow his research work until his death in 1925. Kulchitsky's scientific work extended over a wide field of histological investigation, ranging from studies on the intestinal epithelium to the comparative anatomy of nerve-endings in muscle. He will always be remembered for his discovery of the cells of the intestine that at one time carried his name. Nowadays these cells are known as argentaffin or enterochromaffin cells, and their function is still not clear. They have been thought to be neurosecretory or concerned with the absorption of vitamin B_{12}; but many workers consider that Kulchitsky's own suggestion that they produce secretin may well be correct. He was an admirable technician, and his name is continually recalled to neurologists by his modification of the Weigert method that made possible the better staining of myelinated nerve fibres.

Benjamin Franklin in Britain

Benjamin Franklin made his first visit to London in 1724, when still an unknown lad. His second visit, lasting from 1757 until 1762, was made as a delegate of the General Assembly of Philadelphia, and during these five years he was in close touch with the Royal Society, of which he had been elected Fellow in 1756, and the newly founded Society of Arts (see also *Nature* of January 14, p. 60). When Prof. E. N. da C. Andrade delivered the Trueman Wood Memorial Lecture to the latter Society on January 18, he took as his subject "Benjamin Franklin in London". After giving a brief account of Franklin's early life, and his electrical experiments, Prof. Andrade turned to his visits to England, and described his close association with scientific circles in London during his second and third visits to England. The latter extended from 1764 until 1775. Over nearly two decades, Franklin was closely associated with the administration of

both the Society of Arts and the Royal Society, attending many committee meetings of the former and serving four times on the Council of the latter. A Franklin Commemorative Medal was presented to the Royal Society of Arts during the meeting.

Franklin was a member of many other scientific societies, including the Royal Society of Edinburgh. At a meeting held in the rooms of this Society on January 16, lectures were given by Prof. A. D. Ritchie, professor of philosophy in the University of Edinburgh, and Dr. W. P. D. Wightman, reader in the history and philosophy of science in the University of Aberdeen, on "Franklin's Political Career and Philosophical Outlook" and "Franklin as a Natural Philosopher", respectively. Both lecturers commented on Franklin's wide interests and great gifts. When he visited Edinburgh in 1759, he was made a burgess by the Town Council, and became a member of the Philosophical Society, the forerunner of the Royal Society of Edinburgh itself. The latter Society elected him as one of its first honorary fellows. The meeting opened with the presentation by Mr. E. D. Kuppinger, American Consul-General in Edinburgh, of a Franklin Commemorative Medal to the Society.

Geological Society of London: Awards for 1956

THE Geological Society of London has made the following awards for 1956: *Wollaston Medal*, to Prof. Arthur Holmes, professor of geology in the University of Edinburgh, for his world-wide interests in petrology and petrogenesis and the application of radioactivity to the problem of geological time; *Murchison Medal*, to Dr. F. M. Trotter, assistant director of H.M. Geological Survey, for his studies of the structure and stratigraphy of the Carboniferous rocks of England and Wales, especially in relation to coal and iron; *Lyell Medal*, to Dr. L. R. Cox, of the British Museum (Natural History), for his palæontological researches, especially on the Mesozoic and Tertiary molluscs; *Wollaston Fund*, to W. B. Harland, of the University of Cambridge, for his researches on the structure and stratigraphy of Spitsbergen; *Murchison Fund*, to Dr. W. W. Black, of the University of Cambridge, for his research work on the sedimentation and contemporaneous structures of the Carboniferous Limestone; *Lyell Fund*, a moiety to Dr. W. S. Pitcher, of King's College, London, for his researches on the igneous and metamorphic rocks of Donegal and on the Tertiary and Pleistocene deposits of south-east England, and another moiety to H. R. Tainsh, chief geologist of the Burmah Oil Company, for his researches on the geology and oil resources of Burma.

Two New Research Reactors at Harwell

THE United Kingdom Atomic Energy Authority has announced that two new reactors (or atomic piles) are now operating at Harwell—ZEUS (zero-energy uranium system) and ZETR (zero-energy thermal reactor)—both of which are for research purposes only and run at very low power-levels. ZEUS has a cylindrical core, roughly 20 in. in diameter and 20 in. long, which is made of uranium very highly enriched in the rare isotope uranium-235; the enriching was carried out at the Atomic Energy Authority's factory at Capenhurst, near Chester. The core is surrounded by many tons of uranium in which plutonium is formed gradually as the pile runs. The very low power-level of 100 W. at which the reactor is operated is such that no cooling is required, although the rate of the nuclear reaction is adequate for making experimental measurements. It has been built to check the nuclear calculations on which depends the design of the fast reactor of about 60 MW. which is being built at Dounreay in the north of Scotland, and in many essentials it is a full-scale version of the Dounreay reactor. The other research reactor, ZETR, uses a nuclear fuel in solution and is intended to provide information about the quantities of fuel which will be required for large-scale reactors using such solutions. Plutonium has already been studied in this reactor; uranium-235 is being studied now and uranium-233 is to be studied later this year. Natural water is used as a solvent at present; but in the summer heavy water is to be used.

The Derbyshire Earth Tremor of January 10

AN earth tremor, accompanied by a low rumbling sound, occurred in Derbyshire on January 10 and was felt in many places in Derbyshire, Leicestershire, Rutland and Nottinghamshire. Up to a distance of some ten miles from the epicentre, windows and crockery rattled, and cases occurred of beds moving and pictures falling from walls. At Woodhouse Eaves in Leicestershire, the tremor appeared to come from the north. The shock was reported from Derby, Leicester, Nottingham, Burton-on-Trent, Ashton-on-Trent, Melton Mowbray, Rothley, Coalville, Heanor and Castle Donington. It was recorded on the Milne–Shaw horizontal seismograph at Bidston Observatory, near Liverpool, at 08h. 12m. 14s. G.M.T., and on the short-period vertical seismograph (made at Kew) at Kew at 08h. 12m. 21s. G.M.T. The shock was also recorded at Durham University Observatory and at Rathfarnham Castle, Dublin. It was just recorded at the Royal Observatory at Edinburgh, but not at Aberdeen. From the readings it appears that the epicentre was to the south-east of Derby (near 52° 50′ N., 1° 25′ W.), and the initial time was 08h. 11m. 51s. G.M.T.; the depth of focus was probably about 12 or 13 km. There may have been an aftershock from the same district a little after 10 a.m.; but the recording of this is doubtful owing to microseisms, and also waves arriving from an earthquake in the Pacific.

The earliest earthquake noted from Derbyshire occurred in the year 1084, and there were further earthquakes in November 1678; October 31, 1734; July 10, 1738; and June 26, 1748; but the largest shock was on November 18, 1795, about 11.10 p.m. On that occasion, chimneys were thrown down at Derby, Nottingham and Ashover, and the shock was felt as far away as York, Liverpool, Bristol, London and Norwich. A shock with its epicentre four miles south-east of Derby was felt on November 13, 1872, about 4.10 p.m. Earth tremors occurred at Winster in Derbyshire in 1952. That of February 22 at 9.20 a.m. had intensity VI on the Modified Mercalli Scale. More feeble shocks occurred on February 24, March 17 and two on April 15. The tremors in 1952 were probably due to geological fault adjustments along the branch faults which are a continuation of the Crich–Cromford–Bonsall fault belt. A further slight tremor occurred at Winster on November 15, 1954. The shock rattled doors, windows and crockery, and a crump-like sound preceded the tremor.

Royal Society and Nuffield Foundation Commonwealth Awards

AWARDS under the Royal Society and Nuffield Foundation Commonwealth bursaries scheme have

been made as follows: Dr. A. Bose, reader in physics, Indian Association for the Cultivation of Science, Calcutta, to study the techniques of paramagnetic resonance at the Clarendon Laboratory, Oxford (January 1956–January 1957); Dr. H. B. S. Cooke, senior lecturer in geology, University of the Witwatersrand, to study African fossil mammal collections in the British Museum and the Powell–Cotton Museum with the view of taxonomic determination of ungulate cranial and skeletal material in Africa, and also to study modern methods of age-determination applied to Quaternary deposits and related fossil material (January–June); R. G. Cooke, senior lecturer in organic chemistry, University of Melbourne, to study modern techniques in the isolation of natural products and in the determination of molecular structure at the University of Cambridge (February–August); G. C. Israel, senior lecturer in physical chemistry, University of Hong Kong, to enable him to study modern methods of research in chemical kinetics and mechanisms at University College, London (September 1956–March 1957); Prof. L. C. King, professor of geology, University of Natal, to carry out field studies in Australia on the sequence of cyclic denudational landscapes, on pediplanation and on the relation of soils to landscape evolution (January–March); A. D. McKay, Matopos Research Station, Southern Rhodesia, to study problems and techniques in pasture research and ecology in semi-arid areas of Australia with particular reference to management and use of natural grasslands (for about four months from September); Dr. K. G. McNeill, lecturer in natural philosophy, University of Glasgow, to work with the research group on the 23-MeV. betatron at Saskatoon (June–August); G. B. Masefield, University demonstrator in tropical agriculture, Department of Agriculture, Oxford, to observe the characteristics of nodules on the roots of annual leguminous crops at four widely dispersed centres in the typical wet-tropical environment of Malaya (June–September); S. Smith-White, senior lecturer in botany, University of Sydney, to discuss at Oxford, the John Innes Horticultural Institution and elsewhere his researches into cytological conditions in the Australian flora and other matters (for about twelve months from January); Dr. A. M. Stephen, lecturer in organic chemistry, University of Cape Town, to work at Edinburgh, in a study of carbohydrates, with emphasis on polysaccharide structure determination, and also of biochemical aspects of carbohydrate metabolism (January 1956–January 1957); M. W. Tracey, Rothamsted Experimental Station, to study the methods in use and being developed at Melbourne for the study of cellulase and the microbial degradation of keratin (January–December).

Manchester Literary and Philosophical Society

The Council of the Manchester Literary and Philosophical Society proposes to publish a history of the Society from its foundation in 1781. Unfortunately, the Society's home was destroyed by enemy action in December 1940, and there perished with it not only the Society's Library but also all its Minute Books and other records. The Council wishes, therefore, to enlist the help of any former members or other persons who possess or know of any material which throws light, however dim, upon the history and development of the Society at any period. It would be grateful for any bibliographical references to allusions to the Society, however obvious they may seem to be. Any original material forwarded would be copied and returned with the minimum of delay. It is proposed to issue the history at the time of opening the Society's new building, the construction of which will shortly begin. Communications should be sent to Dr. W. H. Brindley (honorary librarian) or F. Willett (honorary editorial secretary) at the Society's present address, Portico Library, 57 Mosley Street, Manchester 2.

Agricola's Position in Science

President Herbert C. Hoover had an extraordinary career as a mining engineer in Asia, Europe, Africa and America before he became the thirty-first president of the United States in 1929. In 1912 he and the late Mrs. Hoover published their translation from the Latin of Agricola's classic work, "De Re Metallica". The introduction to their work has been reprinted in a recent issue of the *Scientific Monthly* (**81**, No. 5; November 1955). Mr. and Mrs. Hoover suggest that, in his departure from the peripatetic school of the Greeks by making use of observed facts, Georgius Agricola must rank as one of the truly great pioneers of science.

Electric Fencing against Game

Experiments in Africa to keep wild animals inside reserves or away from areas required by man are described in *Oryx* (**3**, No. 3; November 1955). In the first experiment one strand of steel wire was mounted at a height of 15 in. around the outside of a plot roughly a hundred acres in area. The power unit for the fence was an ordinary electric fencer of the type used by farmers for fencing cattle and was run from a six-volt car battery. This was effective against bush-pig and bush-buck and against baboons when erected in the manner described above. It was not effective against monkeys. In a second experiment a strand of steel wire was erected 40 in. high and was intended to be a barrier to the movement of large animals along the west side of Lake Manyara. Unfortunately, the results of the experiment were masked by conditions which could not be controlled but were still encouraging enough to indicate that electric fencing is a possible method of restricting the movement of game.

Geological and Geomorphological Research in the South-West of England

A conference of geologists and geomorphologists was held in the University of Exeter during January 5–7, with the object of encouraging the development of research in the South-West of England by promoting contact between those engaged in it. There are about seventy geologists and geomorphologists directly or indirectly doing research on problems of the area, and, of these, fifty-two were present, including fourteen postgraduate students at universities; nine of those attending were geomorphologists and geographers rather than geologists. The formal sessions were not intended for the announcement of work done but for the discussion of matters of general interest. The chief topics discussed were: the palæontology of the Devonian, the stratigraphy of the Culm, the pegmatites, the folding and faulting, the Lizard and Start boundaries, and high-level surfaces on Exmoor and Dartmoor. It was agreed by all that the conference had been highly successful, and it is hoped to arrange a further conference next year.

Bradford Symposium and Exhibition on Radiochemistry

THE Bradford Chemical Society, in conjunction with the Department of Chemistry and Dyeing of the Technical College, Bradford, and the Yorkshire Council for Further Education, is arranging a symposium on radiochemistry and an exhibition of radiochemical and chemical apparatus, to be held in the Technical College, Bradford, during February 17–18. The symposium will take the form of a short course on the subject, and four lectures will be given, as follows: basic principles of radiochemistry (Dr. G. B. Cook), measurement of beta- and gamma-radiation (Dr. D. Taylor), estimation of isotope concentrations (A. A. Smales) and applications to chemical problems (Dr. D. R. Stranks). The symposium and exhibition will be open, without charge, but to help in the arrangement of accommodation for lectures and demonstrations, intending visitors are requested to inform Dr. W. R. Moore, of the Department of Chemistry and Dyeing, Technical College, Bradford, to whom all inquiries should be addressed.

The Night Sky in February

NEW moon occurs on Feb. 11d. 21h. 38m., U.T., and full moon on Feb. 26d. 01h. 41m. The following conjunctions with the Moon take place: Feb. 5d. 05h., Saturn 3° N.; Feb. 6d. 07h., Mars 0·2° N.; Feb. 9d. 22h., Mercury 1° S.; Feb. 15d. 11h., Venus 6° S.; Feb. 25d. 11h., Jupiter 6° N. Mercury rises about 7h. at the beginning of the month and is then too close to the Sun for observation, but at the middle and end of the month it rises at 6h. 10m., in the former case more than an hour before sunrise and may be visible for a short period though it lies rather low for good observation in the British Isles. Venus sets at 20h. 10m., 20h. 45m. and 21h. 30m. at the beginning, middle and end of the month, respectively; its stellar magnitude varies between −3·5 and −3·6 and the visible portion of its illuminated disk between 0·793 and 0·705 during the month, its distance from the Earth during this period varying from 113 to 96 million miles. Mars rises shortly before 4h. during February. Its eastward motion through Ophiuchus into Sagittarius and its position a little south of μ Sagittarii at the end of the month is easily observed, though it lies rather far south for good observation during this time; its stellar magnitude varies from 1·5 to 1·2, due to its distance from the Earth decreasing from 170 to 147 million miles during February. Jupiter rises early in the evening and is visible throughout the night, setting at 8h. 30m., 7h. 30m. and 6h. 30m. on February 1, 15 and 29, respectively, and is a conspicuous object (stellar magnitude −2·1) in the constellation Leo, in which it has a westward motion. Saturn rises at 2h. 55m., 2h. 05m. and 1h. 15m. at the beginning, middle and end of the month, respectively, and lies a little north of β and γ Scorpii, but is too low for good observation in the British Isles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Feb. 1d. 01h. 32·0m., *q* Vir. (*R*); Feb. 14d. 18h. 25·5m., 19 Psc. (*D*); Feb. 19d. 20h. 10·9m., 51 Tau. (*D*); Feb. 19d. 20h. 55·7m., 56 Tau. (*D*); Feb. 20d. 00h. 34·4m., 247*B* Tau. (*D*); Feb. 20d. 19h. 42·7m., *n* Tau. (*D*); Feb. 20d. 23h. 47·6m., o Tau. (*D*); Feb. 23d. 22h. 25·6m., 29 Cnc. (*D*); Feb. 24d. 23h. 57·7m., ω Leo *m* (*D*). *R* and *D* refer to reappearance and disappearance, respectively.

Announcements

THE first award of the William Froude Medal of the Institution of Naval Architects has been made to Sir Thomas Havelock, lately professor of mathematics in the University of Durham (King's College, Newcastle upon Tyne). The William Froude Memorial Fund was launched by the Institution in 1952 to enable a plaque to be placed on the site of the original experimental tank at Torquay and to publish Froude's technical papers. These have been done, and from the small balance still remaining in the Fund the Institution will offer this gold medal from time to time for "some outstanding contribution to naval architecture and shipbuilding".

THE Zoological Society of India has awarded the Sir Dorab Tata Gold Medal to Dr. M. L. Roonwal, forest entomologist in the Forest Research Institute, Dehra Dun, for his contributions to zoology during 1952–54. Dr. M. L. Roonwal's work has been concerned with termites and Teredinid boring bivalves in relation to forestry, and also with phase-transformation and population dynamics of the desert locust.

PROF. P. W. RICHARDS, professor of botany in the University College of North Wales, Bangor, and Mr. H. Wardale, a Northumberland hill farmer, have been appointed to the National Parks Commission. Brigadier P. B. E. Acland, Dr. Nancy G. Davies and Mr. W. B. Yapp have been re-appointed members of the Commission. Prof. R. C. McLean has resigned.

PROF. E. G. WHITE, professor of veterinary preventative medicine in the University of Liverpool, has been appointed a member of the Agricultural Improvement Council for England and Wales to fill the vacancy created by the death of Prof. F. Blakemore.

DR. JESSE E. HOBSON, director since March 1948 of the Stanford Research Institute, Menlo Park, California, is resigning because of ill health. Dr. Hobson, who is an electrical engineer, was director of the Armour Research Foundation for four years prior to his appointment to the Stanford Research Institute. At that time the staff of the Institute numbered less than fifty and its research budget 250,000 dollars a year; it is a tribute to Dr. Hobson's leadership that during the past eight years the Institute has grown to a staff of twelve hundred and a budget of 10½ million dollars.

MR. RALPH H. ATKINSON has retired as head of the Platinum Metals Section of the Research Laboratory at Bayonne, New Jersey, of the International Nickel Company. A graduate of the University of Cambridge, Mr. Atkinson was a lecturer in chemistry and metallurgy at Cambridge before joining the Mond Nickel Company in 1923 as assistant manager of its platinum metals refinery. He moved to Canada early in 1940 and has held a number of appointments there and in the United States, mainly with affiliated organizations of the International Nickel Company. His research at Bayonne has been on metallurgical and electrochemical problems in connexion with the applications of the platinum family of metals, with special regard to the soldering and casting of palladium.

A MEMORIAL service for Prof. A. O. Rankine, emeritus professor of physics in the Imperial College of Science and Technology, London, who died on January 20, will be held in the Queen's Chapel of the Savoy, London, W.C.2, on February 2 at noon.

FIRST INTERNATIONAL CONGRESS ON DOCUMENTATION OF APPLIED CHEMISTRY

THE First International Congress on Documentation of Applied Chemistry was held in London at the Institut Français, South Kensington, during November 22–25, and at the final session its claim to the title "First" was substantiated when the members, by a substantial majority, agreed to recommend that the International Union of Pure and Applied Chemistry, which sponsored the meeting, should sponsor the "Second" in about three years time. It was abundantly clear that this Congress had not been called any too soon. As the president of honour, Lord Cherwell, said, when he spoke at the opening session, he was appalled, in general, at the rate of change going on in the world and, in particular, at the rate at which scientific literature is increasing; he charged the Congress with the task of finding the best ways of putting this mass of information at people's disposal.

The first morning session was devoted to the international scene, with Dr. L. H. Lampitt as chairman. A general survey was given by Prof. H. R. Kruyt, whose broad outlook on international matters is so well known; he made a plea, not new but still as urgent as ever, for abstracting, which is a service to the whole world, to be organized on an international footing. Prof. G. A. Boutry then spoke on the Abstracting Board of the International Council of Scientific Unions, which has done so much for speeding up the publication of abstracts. Its work, however, is not well known to chemists as its initial efforts have been directed towards physics abstracting, but it is now concerning itself with chemical abstracts. Prof. Boutry said that authors' summaries are used in the case of about a third of the world's physics papers; this led to considerable argument as to the value of authors' abstracts and to a general discussion on the various purposes for which abstracts were required, the abstracting of 'letters to the editor', of patents and of 'semi'-publications (brochures, technical advertisements, etc.).

When Dr. Lampitt introduced Dr. N. Grell, who read a communication from M. R. Grégoire, of the Organization for European Economic Co-operation, he said that relatively few people know what the European Productivity Agency is or what it does. Dr. Grell gave an interesting survey of the work of the Agency, the aim of which is to improve the standard of living through increased productivity, and of its publications, notably its "Technical Digests". To. M. Jean Gérard's criticism that this information is not of the kind required by research workers, Dr. Grell emphasized that their readers range from scientists to factory workers. Prof. P. Auger, of the United Nations Educational, Scientific and Cultural Organization (Unesco), then gave a résumé of the scientific programme of his Organization, Dr. Lampitt emphasizing how difficult it had been to "get the 'S' put into UNESCO". The incentives for peace, said Prof. Auger, are one language and one fight: science is always a universal language; and the common fight is that against the adverse forces of Nature. Unesco's aim, he said, is to strengthen the links between the world's scientists, to organize the meeting of scientists and to create international bodies. This stimulating paper led to a long discussion on *rapprochement* with the U.S.S.R., which the chairman had to restrain; but, to an onslaught on lack of collaboration, led by Dr. D. J. Urquhart, Prof. Auger replied laconically, "There is hope", while the spokesman for the Russian delegation hinted that co-operation is on the way.

The afternoon session, under the chairmanship of Sir Alfred Egerton, reviewed the national scene, and this was a full afternoon's programme as papers were read by the representatives of seven nations. Prof. J. Wyart (France) advocated, not without criticism, machine-made abstracts to improve further an already improving situation in French documentation; Prof. E. Velander (Sweden), reading a paper on behalf of Mr. E. Engel, who was ill, reported excellent co-operation on documentation between the Scandinavian countries; and Dr. J. M. Meyer showed how a small country like Switzerland has to rely on international documentation and how valuable *Chemical Abstracts* and *Chemisches Zentralblatt* are to his country. Dr. M. G. Mellon (Purdue University), in his review of the situation in the United States, pointed out that he now teaches a course in chemical literature for which up to a hundred and fifty students enrol and that such courses are now held in about twenty-five out of several hundred American colleges; one speaker afterwards pressed for students to be taught the value of abstracts. Dr. U. V. Panov (U.S.S.R.) promised co-operation between Russia and the West, the difficulties of transliteration being freely admitted, while Dr. A. Gorter (Holland) lamented the limited application of the Dutch language in documentation.

Only Dr. D. J. Urquhart among the national speakers stirred up controversy, when speaking for Great Britain. Claiming that chemistry is in the vanguard of scientific information, he contended that the quantity of literature will outgrow our intellectual resources and that sooner or later there will be a shortage of scientists. The under-developed countries will then contribute more, and he appealed for a *lingua scientifica* in order to cope with it.

Prof. Velander was chairman of the first session on the second day, when the whole day was given up to particular problems. An excellent start was made with Prof. R. R. Shaw's vivid description of his "Scarecrow Press", strangely enough a serious publishing concern aiming at printing scholarly books where the required edition is as low as 1,500–300 copies, or even as low as twenty-five copies, and would not therefore be considered by ordinary publishing firms. He described how he had aimed at cutting costs to the minimum, and he contended that for scientific books the authorship, editing, etc., should be free and that only the actual production of the book should be charged. Instances were given where valuable but highly specialized books are at a prohibitive price. Dr. E. B. Hughes, deputy chief chemist of J. Lyons and Co., speaking on abstracts, said how important it is to get the abstracts to the chemist, and he advocated selective abstracts, as the average research chemist cannot afford volumes like *Chemical Abstracts*, valuable as they are. He introduced a wistful note in lamenting the passing of the high-quality abstracts of the Chemical Society of

thirty-five years ago. Dr. V. V. Serpinsky, editor of the *Russian Chemistry Abstracts Journal*, speaking on the same subject, emphasized how young his journal is, but he believed that it will ultimately make a useful contribution. In the discussion on abstracts that followed, doubt was again expressed on the value of authors' abstracts, and the need was stressed for experience and specialized training in abstracting: Dr. Grell favoured 'digests', bigger than abstracts, and therefore on a more limited scale.

Dr. B. Agard-Evans, Ministry of Works librarian, discussed special documents, having in mind pamphlets and the like, the technical content of which is often important and yet often lost. His organization, he said, in spite of much expense and labour, covers only about 25 per cent of such publications from abroad.

At the next session, with Prof. A. Nasini (University of Turin) in the chair, Prof. M. Lora-Tamayo (University of Madrid) described with great effect the problem of language, with examples of the technical terms in the steel and other industries in English, Spanish and other tongues; any language, he said, even if safeguarded in its purity, is confronted with invasion of foreign technical terms. Dr. J. E. Holmstrom (Unesco) talked on multilingual technical dictionaries which he held to be indispensable, although he warned the Congress that existing ones are deficient in many respects and that the creation of new ones is difficult. To this end Dr. R. S. Cahn stressed that of nineteen thousand papers on chemistry in 1954, 60 per cent were in English, 13 per cent in German, 9 per cent in Russian, 7 per cent in French, and smaller proportions in Japanese, Italian, Spanish, Portuguese and others. The theme of the paper by Dr. E. Pietsch (director of the Gmelin Institute) was whether man can produce a store of facts greater than the human brain by extrahuman systems; he elaborated many of the mechanical methods, electronic systems, punched-card systems, microfilms and so on, and gave examples of the use of International Business Machine cards.

Dr. E. J. Crane (editor of *Chemical Abstracts*) said, on the subject of indexing, that for every thousand words of abstracts there now has to be seven hundred words of index. He insisted that trained abstractors are essential, for though machines are useful, they have to rely on accurate information being fed to them. A discussion on subject-indexing followed, and Dr. Crane intimated that the new building for *Chemical Abstracts* would have facilities for research into methods. The session ended with a paper on library and technical information services by Miss Elin Törnudd (Finland), the only woman contributor. "The customer is always right," she said, and inquiries have shown that 90 per cent of potential users of the lists of titles in her information bulletins in Finland do in fact use them; 70 per cent are in favour of not translating titles, except those in Russian. This was confirmed by one speaker on fuel abstracts, who said that speed in publication of titles is more important than the actual abstracts.

Prof. W. A. Noyes (editor of the *Journal of the American Chemical Society*) adroitly controlled from the chair a fast-moving session on the third morning of the Congress. After Prof. A. Scortecci's paper on the role of governments in organizing documentary information services, Prof. Noyes asked whether such services should be centralized, but Prof. Scortecci contended that separate subjects are so specialized that they should be left to the specialists. He agreed, however, that a general classification of information is desirable but that special fields require special classifications. Dr. R. E. Fairbairn (Imperial Chemical Industries, Ltd.), in the absence of the author, Mr. J. D. Rose (of the same firm), read a paper on the role of industry. In a provocative speech he contended that abstracts are too late for current information and that inadequate indexing makes search for past information unreliable; in spite of a protest from Dr. Crane, he insisted that abstract indexes are anything up to five years late. A spirited discussion followed on what the users of abstracts in industry really want, and it was generally agreed that the great need is for current information services.

A stimulating paper on the role of professional and learned societies was given by Dr. Cahn, editor to the Chemical Society, in which he demanded the reorganization of publishing methods, cuts in costs, greater support from industry and a users' conference; the financial position of professional societies is serious, he said, although there is no shortage of manuscripts for publication. The last paper of the session was a thoughtful contribution by Dr. J. Knox (Department of Scientific and Industrial Research) on "How can Further Co-operation Take Place?", to which M. Jean Gérard replied at length.

The final session opened with a paper by Mr. A. W. Marsden, director of the Commonwealth Bureau of Dairy Science, on the often-forgotten subject of chemistry applied to agriculture and on the information services provided by the Commonwealth Agricultural Bureaux. He was followed by a talk by Mr. N. M. Javaronkov, of the Russian delegation, the theme of which—collaboration—was taken up enthusiastically by the meeting. A small voice mentioned, for the only time during the whole Congress, the possibility of Esperanto to overcome language difficulties.

A brilliant summary of the proceedings of the Congress was given by Mr. F. P. Dunn, honorary publications secretary of the Society of Chemical Industry, in which he concluded with a list of the suggested resolutions put forward by various delegates during the six sessions. Dr. L. H. Lampitt, chairman of the final session, sought the advice of the meeting as to what positive action the Congress should take to implement the results of its discussions. A vigorous minority wanted to discuss the eight individual resolutions one by one, but the meeting decided, by a substantial majority, to put up two resolutions: first, that the International Union of Pure and Applied Chemistry, the sponsoring body, should call a second Congress in about three years time; and secondly, that Mr. Dunn's summary of the proceedings and the headings of recommendations enumerated by him be referred to the Organizing Committee of the Congress for submission to the Union.

There is no doubt that this Congress served a very useful and, above all, a timely purpose. The increase in scientific literature, on applied chemistry alone, is terrifying and, although at this Congress much time was wasted by some boring repetition and by many people grinding their personal axes, the general feeling that international co-operation and the application of the most modern methods of documentation are the solutions was echoed by Sir William Ogg, the chairman of the Congress Council, in his valedictory address. Two points he made were that, although English used to be international and

is still nearly the *lingua scientifica*, scientists must learn more languages, not only Russian, and that consideration should be given to the fact that, whereas in the U.S.S.R. scientific documentation is a State matter, in Great Britain it is dependent on industry and the business houses.

The success of the Congress was borne out by the attendance of more than three hundred delegates, about one-third of whom were from overseas. There was a full programme of excellent social events.

SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING IN LONDON

ABOUT a thousand science masters met in London at the Royal College of Science, South Kensington, for four days in the week between Christmas and New Year, the occasion being the annual meeting of the Science Masters' Association. Residential accommodation was provided, as usual, at Queen Elizabeth College, Campden Hill Road, which also entertained visitors in its laboratories on two evenings. Teachers were present from the Netherlands, Natal, Pakistan and India, and Unesco sent an observer.

For his presidential address, Sir Edward Salisbury, director of the Royal Botanic Gardens, Kew, chose the theme "Science and Education". He began by saying that his life had been spent in the study of ecology, from varied approaches, and that this might have been no bad preparation for suggesting ways in which the disciplines derived from different studies might be integrated. The greatest danger to real education, he said, is to mistake the provision of information for the imparting of knowledge; it is much easier to acquire strands of information than to weave them into a harmonious whole. Science teaching should therefore stress the structural unity of all knowledge. He recalled that the test he applied when he taught botany students was to ask whether their studies made a walk in the country more interesting; if not, they should try some other subject. He thought that a similar test might well be applied to all learning: Does it make life richer and more colourful?

A marriage of science and the humanities is essential to the success of the civilization of the future, and in order to achieve this, Sir Edward thought that the scientist should write good English and that the humanist should take the trouble to understand him. He deplored the passing of the general use of the Bible, which had set a standard of English expression, not less valuable because often unconsciously acquired. Science, he went on, should set itself not only to amass facts but also to create good citizens; but it should beware of exaggerating the importance of what is measurable, since some most significant things are not to be measured. Good science teaching should avoid the pitfalls of doctrinaire politics and ensure a sense of proportion and a balanced judgment, though these are not qualities gaining publicity in the more sensational newspapers. Sir Edward also said that the need in schools is to stress the fact that to live is more than livelihood, and that only by habitual zest in one's working-hours can one ensure the zestful enjoyment of one's leisure. "To go slow in the one is the surest way of finding that time hangs heavy in the other". On the science teaching in schools there rests a great responsibility, but there are also the potentialities of a great achievement.

Each morning of the meeting began with two simultaneous lectures, those on the first morning being by Prof. L. J. Audus (Bedford College, London) on the attempts made during the Second World War by biologists in Japanese prisoner-of-war camps to stem the onset of deficiency diseases; and by Dr. C. C. Butler (Imperial College of Science and Technology, London) on the story of cosmic rays. The lectures on the second morning were by Prof. R. M. Barrer (Department of Physical Chemistry, Imperial College, London) on crystals as molecular sieves, and by Prof. F. A. Vick (Department of Physics, University College of North Staffordshire) on electrical aspects of contacts between solids. On the last morning lectures were given by Prof. R. J. Harrison (London Hospital Medical College) on recent research on whales and seals, illustrated by a film, and by Mr. H. W. Thorp (Department of Chemical Engineering, University College, London) on chemical engineering, which was also illustrated by films; a third lecture, later on the same morning, was by Mr. A. B. Soper (Cable and Wireless, Ltd.) on Commonwealth telecommunications.

Some of the most popular functions were the demonstrations and discussions. A lecture-demonstration on experiments with radioactive isotopes suitable for schools had to be repeated four times, the first version being attended by more than two hundred, who somehow got into a lecture theatre built for seventy; it was given by M. C. Nokes (Harrow), J. S. Strettan (Raynes Park Grammar School), T. A. H. Peacocke (St. John's School, Leatherhead), G. E. Perry (Kettering Grammar School) and W. G. Rhodes (Firth Park Grammar School, Sheffield). Another most popular demonstration was by K. A. Murch (Chichester High School for Boys) on ciné and ciné-micrography in the teaching of natural history.

A very valuable and provocative discussion, under the chairmanship of Mr. F. W. Kaye, was that on science in secondary modern schools—progress and prospects; it was initiated by A. E. J. Trinder (Alexandra Secondary Modern School, Bromley), and many members took part. The discussion on the last morning was on first-year failures in the universities, and for this Dr. H. F. Boulind (general secretary of the Association) was in the chair. It was introduced by Dr. E. R. Roberts (Department of Inorganic Chemistry, Imperial College) and by Prof. F. A. Vick. Representatives of the various colleges of the University of London had been invited to be present, and several spoke. It was generally agreed that the schools need to concentrate on trying to make pupils think, rather than on giving instruction for examinations, but how this is to be done was not so apparent. It is hoped that a tape-recording of the discussion may later be put into print. The third discussion was one by the Science and Religion Group of the Association, which was welcomed by the Rev. D. W. Cleverley Ford, vicar of Holy Trinity Church, Prince Consort Road, London, S.W.7. Many members spoke, and the proceedings ended with a gratifying increase in the numbers of the Group.

Evening functions included a lecture in the Courtauld Hall of Queen Elizabeth College by Mr. T. D. Bourdillon, on "Everest, 1953". Mr. Bourdillon, who was a member of the successful 1953 Everest Expedition, showed and explained the oxygen

equipment and other gear which he used; his lecture was illustrated by most beautiful slides.

As usual, a main feature of the meeting was provided by the exhibitions of apparatus and books by manufacturers and publishers; these, together with the exhibition of teaching apparatus devised by members, were bigger than ever before, and strained the accommodation of the Royal College of Science to the utmost. The Home Office contributed a display of apparatus used in Civil Defence work by technical reconnaissance officers, and also lent a control set and 'walkie-talkies' so that officers of the Association could maintain contact with the secretary's office from any part of the College. Some sixteen firms were visited by members during the afternoons, as also were the High Pressure Laboratories of the Chemical Engineering Department at the Imperial College. In addition, on each afternoon scientific films were shown, some of which were introduced by Dr. J. A. Harrison (Educational Foundation for Visual Aids).

The meeting created a record for attendance, and the Association must count itself as singularly fortunate in this year's president, Sir Edward Salisbury, who insisted on sharing in all the activities; his zest showed that he was not content with precept in his address, but followed it with action during the meeting.

FARMING HISTORY IN GREAT BRITAIN

FARMERS, industrialists and scholars from all over Great Britain attended a joint meeting of the British Agricultural History Society and the Association of Agriculture, which was held in the University of London on December 3. Sir James Scott Watson, president of the History Society, took the chair, and three papers were read, one in the morning and two in the afternoon. This event, which is one of the two annual meetings convened by the Agricultural History Society, is usually open to non-members on payment of the conference fee.

The morning paper, read by Dr. H. Hamshaw Thomas, president of the History of Science Society, dealt with the life and writings of Richard Bradley, F.R.S., who lived in the early years of the eighteenth century. The paper gave much food for thought, for Bradley came very close to some of the most modern scientific discoveries. By a series of experiments he found that variegated leaf colours could be induced in healthy plants by grafting scions of discoloured plants. The variegation, which is really a virus disease, was, he found, transmitted through the circulation of the sap. Similarly, he was able to produce the breaking of tulip bulbs, which was forgotten or neglected until Sir Daniel Hall, all unknowingly, so it is thought, repeated Bradley's experimental work on modern lines. Besides his achievements in pure science, Bradley was a severely practical man. Through correspondents and personal observation he collected and recorded a great mass of information about the farm practice of his day. As Dr. Hamshaw Thomas said, a complete description of English farming methods of the early eighteenth century can be compiled from his work. Until the present day, Bradley has been regarded as somewhat of a charlatan, but Dr. Hamshaw Thomas's work has done much to retrieve his reputation.

After lunch the first paper was by Prof. Cyril Tyler, of the University of Reading, who dealt with the historical development of feeding standards for livestock, a subject that must be very close to the hearts of farmers in these times. Prof. Tyler ranged over the ages from classical times until the present day, describing the theories of the ancients and the slow progress that was made in gaining real knowledge of the subject until von Thaer's work in the early nineteenth century. It was unfortunate that von Thaer chose such a variable as good hay for his basic unit, but his work pointed the way. Many German and British chemists followed in his steps and, with slowly increasing knowledge, have to-day been able to lay down simple and practical rules for the breeder, dairy farmer and meat producer alike. It is a fascinating story and demonstrates, if that is necessary, that the findings of science are of universal application.

The third paper was rather more recondite and dealt with pollen analysis and its bearing on agricultural history, being given by Mr. J. W. Franks, of the Department of Botany, University College, Leicester. Mr. Franks demonstrated how what happened in districts now covered with peat or fen can be discovered by cutting down through the layers. The depth of the layers and other indications show how long they have taken to accumulate. In these layers of peat the pollen of the various flora that flourished is embedded and preserved, and by carefully collecting this pollen, identifying it and counting it, the flora of that particular age can be deduced. If man was living in the place when the pollen was deposited, his activities in growing cereal or other crops, or the effect of grazing animals, will be shown by the different pollens recovered.

All three papers dealt with subjects that were well worth while, and the conference was a great success. Those interested in this field should write to the Honorary Secretary, British Agricultural History Society, Mr. J. W. Y. Higgs, at the Museum of English Rural Life, 7 Shinfield Road, Reading.

GOVERNMENT RESPONSIBILITY IN INDUSTRIAL RESEARCH

THE extent and character of the responsibility taken by governments for research varies enormously. In the scientifically more advanced countries, the government attitude ranges from the benevolence combined with restricted actual participation to be found in Germany and the United States to the complete control of science exercised in the U.S.S.R. Even within the British Commonwealth, where there is a common tradition of government, the countries have developed different ways of reaching the level of research activity essential in a modern State. Some of the differences and the reasons for them were brought out in a discussion on "Government Responsibility in Industrial Research" held at the Society for Visiting Scientists on December 6 under the chairmanship of Sir Henry Tizard. The principal speakers were Dr. E. W. R. Steacie, president of the National Research Council of Canada, and Dr. B. K. Blount, deputy secretary of the Department of Scientific and Industrial Research, and there were contributions from a number of Commonwealth countries and the United States.

Dr. Steacie said that the structure of research in Canada differs markedly from that in Britain or the United States. As a pioneer country, the primary industries developed first, and long before there was a National Research Council research organizations were set up in government departments to deal with their problems. In the initial stages the Canadian secondary industries were mostly branches or subsidiaries of firms in the United States or in Britain, and any research was done by the parent company. This has resulted in a very minor amount of research being done by industry, and a correspondingly greater proportion having to be done by the government for industry.

The National Research Council, charged mainly though not exclusively with the responsibility for industrial research, was set up in 1916 by the Canadian Government at the suggestion of the British Government. At that time there was little secondary industry in Canada, and most of the plants established to meet the needs of the First World War disappeared at its end. It was not until the Second World War that major development of secondary industry took place. In some ways development in Canada has paralleled that in the United States, but "one war behind". In the latter, industrial expansion took place in a period when research by industry was developing in the world generally, but Canadian expansion is happening at a time when there is already a great deal of research abroad. Canada has never gone through a period when there was a large body of research in industry. While there is now a tendency even for subsidiary companies to set up research organizations, the major responsibility for keeping Canada abreast of the times through research falls on government organizations.

It is always difficult to get accurate figures for research expenditures; but the amount allocated in 1954 by the Canadian Government for research in the primary and secondary industries and health was about 43,000,000 dollars, excluding military and atomic energy research; this does not include expenditures by either Provincial authorities or universities. No exactly comparable figures are available; but roughly the Canadian Government is spending twice as much per capita on civil research as the United States Government. On the industrial side, however, the contribution is extremely small. The figures are very unreliable; but they do support the thesis that what is wanted in Canada is a large increase in research in industry rather than by government.

Dr. Steacie went on to describe the organization of research in Canada and the ways in which assistance is rendered to industry. The Department of Agriculture operates large research and demonstration establishments with an annual expenditure of about 17,000,000 dollars. The mining industry is served by the Department of Mines and Technical Surveys, and the ore-dressing laboratory of this Department is particularly noteworthy because the free service which it gives in investigating suitable methods of treatment for the ores from new mines has done so much to aid the development of Canadian resources. The National Research Council, on its own initiative, undertakes long-term research for secondary industry and undertakes shorter-term research under contract for individual firms or groups. The proportion of the expense borne by the industry varies with the circumstances. The research councils of the Provinces work mainly on the shorter-term problems of local industry, sometimes on contract, and in some respects fill the place taken by the large specialized consulting firms and sponsored research in the United States. Research associations, so successful in Britain, are practically non-existent in Canada, partly because of the high proportion of subsidiary firms and partly because of the scattered distribution of industry. Only the pulp and paper industry operates its own co-operative laboratories.

Canada, like every other country, is faced with the problem of getting technical information into the hands of industry. The needs of primary industry are looked after by the appropriate government departments. For secondary industry, lacking research associations as a channel for disseminating information, the Research Council has set up a Technical Information Service which works closely with the Provincial research councils and other bodies in active measures to bring the benefits of new and existing technical information to industry.

Dr. Blount contrasted the Canadian and British conditions, pointing out that Canada is a country with large resources and capable of feeding itself, and that industry in Britain is long established compared with Canada, with a high proportion of craft industry where the best techniques have been found by trial and error over a long period. Even in such industries, however, the need for research is growing because of changing conditions, particularly with regard to raw materials and the need for increased scientific control with the gradual disappearance of the traditional craftsman. The small size of most of the firms gives the opportunity for real help through research associations.

While the figures are not very reliable, the total expenditure on research of all kinds in Britain is probably about £300,000,000, or about one-fifth of the corresponding figure for the United States. It is almost impossible to estimate the government expenditure on research applicable in civil industry, since much of this is included in the budgets of the Armed Services. It is fairly certain, however, that the expenditure by industry is at least equal to that by government, in contrast to the Canadian situation.

After Dr. Blount's talk there were many contributions to the discussion, including a notable one by the chairman himself; but in general three topics were considered: research in India, the difficulty of assessing research effort, and research associations. In India, as in Canada, attention was first given in the past to the primary industries, namely, agriculture and forestry. Now, industrial research is increasing in importance, the expenditure having risen from £50,000 in 1940 to about £900,000. Government research will probably always be dominant in India because of the creation of State industries.

The need for more reliable figures on research expenditures was stressed, particularly as a guide for the distribution of effort in view of the great cost of development and full-scale exploitation as compared with research. Several speakers referred to the value of studying the man-power rather than expenditure, especially in attempting to compare the situations in different countries.

Research associations have been successful in New Zealand where there is a preponderance of small industries; but in Australia they are few in number and indifferently successful. In the United States the place of research associations is taken by the large institutions undertaking sponsored research. Several speakers told of the interest of large firms, and were

of the opinion that the smaller firms which the research associations are particularly designed to help are often "poor members". There was general agreement that the best place to do industrial research is in industry and that, ideally, government and co-operative efforts should cover those fields not adapted to research by individual firms.

AFRICAN HONEY-GUIDES

AMONG the strangest forms of animal behaviour is that of the honey-guides, African birds distantly related to the American woodpeckers, which 'guide' men, baboons and ratels (honey-badgers) to the nests of wild honeybees—supposedly so that these nests can be broken open.

A study of the behaviour is described by Dr. Herbert Friedmann, U.S. National Museum curator of birds, in a bulletin issued by the Smithsonian Institution, Washington. Dr. Friedmann has observed at least twenty-three instances of the habit and has collected other well-authenticated data from African associates.

Dr. Friedmann describes the behaviour as follows: "When the bird is ready to begin guiding, it either comes to a person and starts a repetitive series of churring notes or it stays where it begins calling these notes and waits for the human to approach it more closely. If the bird comes to the person to start leading him, it flies within 15 or 20 feet from him, calling constantly and fanning its tail. If it waits for the potential follower to approach it for the trip to begin, it usually perches on a fairly conspicuous branch, churring rapidly, fanning its tail, and slightly arching and ruffling its wings so that at times its yellow shoulder bands are visible.

"As the person comes to within 15 to 50 feet from it, the bird flies off with an initial conspicuous downward dip, and then goes off to another tree, not necessarily in sight of the follower; it is more often out of sight than not. It waits there, churring loudly until the follower again nears it, when the action is repeated. This goes on until the vicinity of the bees' nest is reached. Here the bird suddenly ceases calling and perches quietly in a tree nearby. It waits there for the follower to open the hive and usually remains until the person has departed with a collection of honeycomb, when it comes down to the plundered bees' nest and begins to feed on the bits of comb left strewn about. The time during which the bird may wait quietly may vary from a few minutes to well over an hour and a half."

African natives regard the bird as an almost infallible guide to honey. They try to attract it by grunting like a ratel or chopping on trees to imitate the sound of opening a nest. Dr. Friedmann suggests that the habit is purely on an instinctive level and is not a deliberately associative act. It presumably originated before the advent of human beings, perhaps starting with the ratel, that still co-operates with the bird, and whose place in the association the African natives have deliberately tried to take. The honey-guide does not seem interested in the honey *per se*, or in the grubs of bees found in the nests. It has an insatiable appetite for the beeswax, which it will take wherever it can be found. With various collaborators, Dr. Friedmann is now carrying out an intensive study of the mechanism of wax digestion.

THE NATIONAL TRUST

ANNUAL REPORT

THE sixtieth annual report of the National Trust, presented to the annual general meeting in Manchester on November 24—the first to be held out of London—records that there are now a hundred and twenty historic houses in the care of the Trust, which owns more than 220,000 acres and has a membership of more than fifty thousand, compared with a membership of seven thousand in 1945 when the Trust had sixty-three houses and owned 107,000 acres, and in 1914 a membership of 725, 5,500 acres and a handful of historic houses. The National Trust Act of 1937 specifically extended the purposes of the Trust to include the preservation of furniture, pictures and other works of art, and since that date the Trust has become responsible for many important collections associated with the country houses under its care. Its responsibility for works of art is likely to increase since the Finance Act of 1953 empowered the Treasury to accept, in payment of death duties, chattels associated with historic houses in the ownership of the Trust. The annual report gives some account of the work of the Trust in this field, and at the annual general meeting Prof. A. B. Blunt, surveyor of the Queen's pictures and director of the Courtauld Institute, who has for some years been the Trust's honorary adviser on paintings, also described some of the maintenance problems that arise.

The report emphasizes that the Trust does not regard its primary duty, in respect of its farmlands and the preservation of the unspoilt landscape committed to its care, as in any way conflicting with the interests of good farming, and the policy of modernizing the farms continues steadily. Deeds of dedication have now been completed with the Forestry Commission in respect of some 4,699 acres of the Trust's 30,000 acres of woodland, including 1,095 acres at Clumber, where, with the release by the Army of 850 acres, the whole property is now open to the public. For the first time since 1947, the accounts show a small surplus (£979) on the maintenance and administration of the Trust's general properties; but, although the income from annual subscriptions increased by some £5,000, legacies and donations are at present decreasing annually, and a large increase in membership is essential if the Trust is to do no more than watch over a fraction of the property requiring its care.

The Trust aims at a membership of seventy thousand before the end of 1956, and, in stressing the urgent need for such an increase, Lord Chorley warned the annual general meeting of the great danger of complacency. The danger to the great country houses is more acute than ever, and at present the Trust can only accept such houses if an endowment for all time is offered with the house. Lord Derby, who also addressed the meeting, stressed the voluntary standing of the Trust and made it clear that the Trust depends on private support and not on national contributions. He said that he was impressed by the small amount of litter left by the public when they visit Knowsley, in contrast with the amount left at many of the Trust's properties where admission is free. Reference was also made at the annual meeting to the launching of a scheme of corporate membership, by which it is hoped to enrol organizations such as industrial firms.

SYNTHESIS AND BLEACHING OF RHODOPSIN

By Dr. GEORGE WALD and PAUL K. BROWN
Biological Laboratories, Harvard University

THE purpose of this communication is to demonstrate in two exemplary experiments certain basic relationships among the principal components of the rhodopsin system.

Rhodopsin is synthesized in solution by incubating together in the dark neo-*b* (7-*cis*) retinene[1] and the rod protein, opsin. It bleaches in the light to a mixture of all-*trans* retinene and opsin[2]. This sequence of reactions is recorded in Fig. 1.

The synthesis of rhodopsin is shown at the left. A solution of cattle opsin in 2 per cent aqueous digitonin was used as blank; the spectrum of opsin, or of the opsin moiety of rhodopsin, is therefore excluded from the record. The same concentration of opsin was mixed with neo-*b* retinene in 2 per cent digitonin, and the spectrum recorded at once in a Cary spectrophotometer (curve 1). Although completed within 20 sec. after mixing, this spectrum already displayed a hump at about 500 mμ owing to the formation of a trace of rhodopsin. Spectra were recorded periodically thereafter in the dark, at the times shown in the legend of the figure. (The light involved in the spectrophotometry is too weak to bleach rhodopsin or to retard its synthesis appreciably.) The concentration of rhodopsin ($\lambda_{max.}$ 498 mμ) rose regularly, while that of neo-*b* retinene ($\lambda_{max.}$ 380 mμ) fell. The reaction was complete in about two hours. The small absorption band at about 350 mμ remaining in the final product (curves 8 and 9) is due primarily to the β-band of rhodopsin[3]. When opsin is in excess, as here, the synthesis of rhodopsin removes neo-*b* retinene almost entirely from solution.

The rhodopsin synthesized at the left of Fig. 1 is bleached at the right. Curve 9 is re-drawn at the right as curve 1. The solution was exposed for measured intervals to the orange light of a 160-W. microscope lamp passing through a Jena *OG2* filter, which transmits all wave-lengths longer than 550 mμ. This region of the spectrum, though it bleaches rhodopsin, is not absorbed by, and so does not isomerize, the retinene formed as product[2]. Immediately following each exposure, the absorption spectrum was recorded in the dark. After a total irradiation of 180 sec. (curve 6), the solution was exposed for 45 sec. to the same source passing through a Corning 3387 filter, which transmits all wave-lengths longer than about 440 mμ (curve 7).

As the irradiation progressed, the rhodopsin maximum fell regularly, and the retinene maximum rose. By curve 7, the solution had been bleached completely, and again contained nothing but retinene and opsin. The retinene formed by bleaching rhodopsin, however, is not the same as enters its synthesis. In such non-isomerizing lights as here employed, the product of bleaching is primarily all-*trans* retinene[2]. This possesses a much larger specific extinction than neo-*b* retinene. Fig. 1 (right) suggests that we had finished with much more retinene than we began; but what in fact happened is that this sequence of reactions isomerized the initial neo-*b* to all-*trans* retinene.

One can regard such a cycle of synthesis and bleaching of rhodopsin as an enzymatic isomerization, catalysed by opsin. In this sense, opsin acts as an isomerase activated by light—a photoisomerase. Neo-*b* retinene is its substrate, and rhodopsin the light-sensitive enzyme-substrate complex.

Fig. 1 contains further internal evidence that the pathway of rhodopsin synthesis differs from that of bleaching. The absorption spectra at the left display a sharp common or isosbestic point at about 422 mμ,

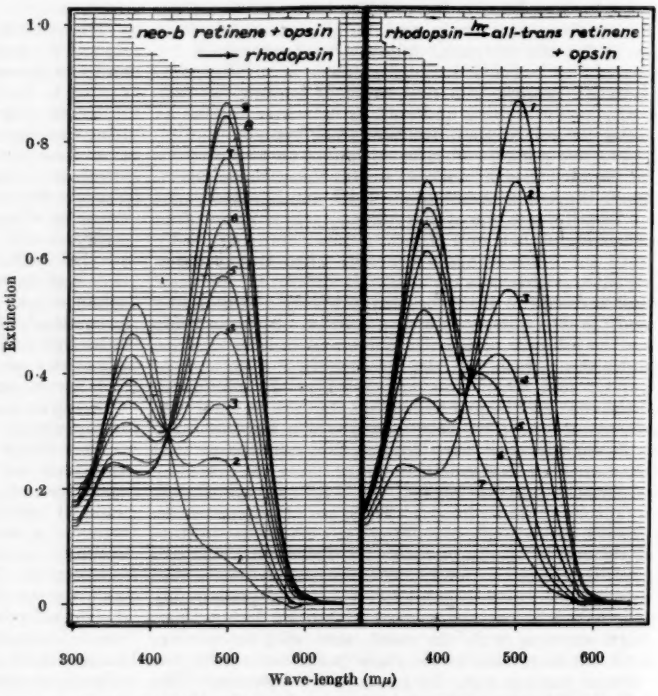

Fig. 1. Synthesis and bleaching of rhodopsin in solution (22·5° C., *p*H 7·0). Left, a mixture of neo-*b* retinene and cattle opsin incubated in the dark, and absorption spectra recorded periodically: (1) at 0·3 min., (2) at 2·5, (3) 5, (4) 10, (5) 18, (6) 30, (7) 60, (8) 120, and (9) at 180 min. The absorption band of neo-*b* retinene (λmax. 380 mμ) falls regularly, whereas that of rhodopsin (λmax. 498 mμ) rises. Right, the rhodopsin formed at the left (1) is exposed to light of wave-length >550 mμ for various intervals, and spectra recorded immediately. The total irradiations are (2) 5 sec., (3) 10, (4) 15, (5) 30, and (6) 120 sec. The residue was exposed for 45 sec. longer to light of wave-length >440 mμ (7)

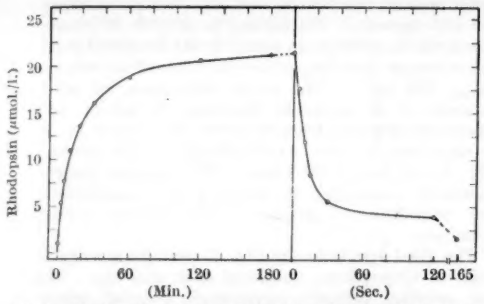

Fig. 2. Kinetics of synthesis and bleaching of rhodopsin, from the data of Fig. 1. Left, synthesis: the points are experimental, the line the theoretical curve for a bimolecular reaction. Right, bleaching: the points are experimental, and an arbitrary line is drawn through them

an indication that only two molecular species—neo-*b* retinene and rhodopsin—are involved in the recording. The curves at the right have no such common point. Bleaching is known to be a more complex process than the over-all equation above these curves expresses. It involves the orange intermediates, lumi- and meta-rhodopsin[4], and the final formation of new complexes between opsin and all-*trans* retinene (see below).

We have spoken of the absorption bands in the ultra-violet as those of neo-*b* and all-*trans* retinene. This is not quite correct. In such solutions, retinene condenses rapidly with amino-groups of opsin and other substances to form Schiff bases which behave as *p*H indicators[5]. These vary in $\lambda_{max.}$ from about 366 mμ at *p*H 9 to about 390 mμ at *p*H 5, and at all *p*H's involve some distortion of the retinene spectrum.

If this factor is momentarily disregarded, we have as molar extinctions in digitonin solution: rhodopsin, 40,600[6]; all-*trans* retinene, 38,300[6]; and neo-*b* retinene, 21,200[6,7]. Therefore we expect that, as neo-*b* retinene forms rhodopsin, $E_{max.}$ should rise 40,600/21,200 = 1·9 times; in Fig. 1 (left) it rises 1·7 times. We expect that as rhodopsin bleaches to all-*trans* retinene, $E_{max.}$ should fall 38,300/40,600 = 0·92 times; in Fig. 1 (right) it falls 0·84 times. These discrepancies are small but cumulative: the isomerization of neo-*b* to all-*trans* retinene should raise $E_{max.}$ 38,300/21,200 = 1·8 times. In Fig. 1 the final retinene maximum at the right is 1·4 times higher than the initial retinene maximum at the left. The over-all yield of the reaction, regarded as an isomerization, appears therefore to be low. One reason for this may be the distortions of retinene spectra by proteins, mentioned above. Another undoubtedly is some degree of isomerization, unavoidable in the course of bleaching. Even such orange lights as used in the present experiment, though not efficiently absorbed by retinene, are absorbed by, and isomerize to some degree, lumi- and meta-rhodopsin[8]. As a result, the product of bleaching always contains small amounts of geometrical isomers other than all-*trans* retinene.

The synthesis of rhodopsin in solution from neo-*b* retinene and opsin follows the course of a second-order (bimolecular) reaction[2]. In the present instance, the initial concentration of opsin, determined in a separate experiment by incubating with excess neo-*b* retinene and measuring the rhodopsin formed, is 28·96 μmoles per litre; and of neo-*b* retinene, 21·35 μmoles per litre. The extinctions of rhodopsin in Fig. 1 (left) are computed from the simultaneous equations:

$$x = E_{500} - 0{\cdot}069\,y\,; \text{ and } y = \frac{3{\cdot}77\,E_{375} - E_{500}}{3{\cdot}70}$$

in which E_{375} and E_{500} are the extinctions at 375 and 500 mμ; y is the extinction at 375 mμ specifically due to neo-*b* retinene, and x the extinction at 500 mμ specifically due to rhodopsin. The latter quantity, divided by 0·0406, yields the concentration of rhodopsin in μmoles per litre.

This has been plotted in Fig. 2 (left). The line which accompanies these points is computed from the equation for a bimolecular reaction:

$$kt = \frac{2{\cdot}303}{a-b} \log_{10} \frac{b(a-x)}{a(b-x)}$$

in which k is the rate constant, t the time in minutes, a and b are the initial concentrations of opsin and neo-*b* retinene, and x is the concentration of rhodopsin. In the present experiment (22·5° C., *p*H 7·0), k has the value 0·0026 litre per μmole per min. (4·33 litres per mole per sec.).

The bleaching of rhodopsin is first-order, provided that the light reaction is limiting, that is, that the 'dark' reactions which remove lumi- and meta-rhodopsin are complete at all stages of bleaching. This condition is not fulfilled in the present experiment. The kinetics of bleaching therefore cannot be treated precisely in this instance. The concentrations of rhodopsin have been estimated from the spectra of Fig. 1 (right) by using simultaneous equations like those above, but differing somewhat in numerical coefficients since all-*trans* retinene replaces neo-*b* retinene in the bleaching mixtures. The points so obtained are plotted in Fig. 2 (right), and an arbitrary line is drawn through them.

The data of bleaching in Figs. 1 and 2 (right) reveal a further complexity. Curves 1–6 in Fig. 1 (right), and also the corresponding points in Fig. 2, form a regular sequence which describes the bleaching of rhodopsin in light of relatively long wave-lengths (> 550 mμ). The final exposure (curves 6–7) involves two important changes: a large increase in the intensity of the light; and the inclusion of much shorter wave-lengths (> 440 mμ). The first change

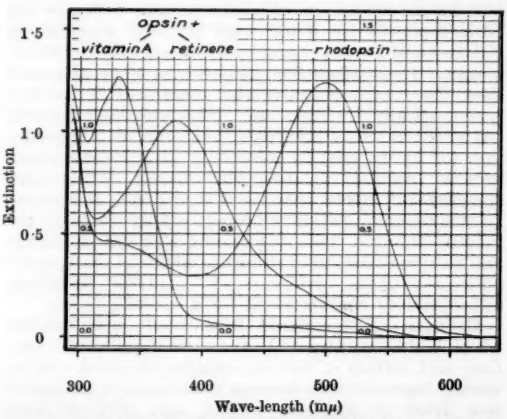

Fig. 3. The bleaching of rhodopsin in solution (23° C., *p*H 7·0). A solution of cattle rhodopsin (λmax. 498 mμ) was bleached in orange light to a mixture of all-*trans* retinene and opsin (λmax. 383 mμ). On adding potassium borohydride, the retinene was reduced to all-*trans* vitamin A (λmax. 325 mμ)

increases the rate of bleaching, the second its character. Whereas the bleaching from curves 1 to 6 involves a maximum fall of extinction at 503 mμ, that from curves 6 to 7 is maximal at a much lower wave-length, 474 mμ. The initial exposure to light of wave-lengths greater than 550 mμ, while bleaching rhodopsin, had permitted the formation of artefacts which absorb at lower wave-lengths: some *iso*-rhodopsin ($\lambda_{max.}$ 487 mμ)[3], and an orange-yellow, light-sensitive pigment with $\lambda_{max.}$ about 440 mμ. The latter is formed in small amounts when retinene is incubated with a number of proteins, including opsin and egg albumin, either in the dark or in lights of sufficiently long wave-length to spare it. Small amounts of this artefact form in the course of every bleaching of rhodopsin in orange or red light.

In the retina, the retinene formed by bleaching rhodopsin ordinarily is reduced to vitamin A. This is accomplished by the enzyme, alcohol dehydrogenase, working together with reduced cozymase (DPN–H)[3]:

$$\underset{\text{retinene}}{C_{19}H_{27}CHO} + DPN{-}H + H^+ \xrightarrow[\text{dehydrogenase}]{\text{alcohol}} \underset{\text{vitamin A}}{C_{19}H_{27}CH_2OH} + DPN^+$$

This reduction can be carried out conveniently in solution with potassium borohydride. A solution of cattle rhodopsin was bleached in a non-isomerizing orange light to a mixture of all-*trans* retinene and opsin (Fig. 3). (In measuring these spectra, digitonin solution served as blank; hence the rising absorption below 310 mμ owing to opsin. In Fig. 1 opsin was in the blank, and its absorption therefore did not appear.) On adding a droplet of potassium borohydride solution in water to the bleached product, the retinene was immediately reduced to vitamin A ($\lambda_{max.}$ 325 mμ). The molar extinction of all-*trans* vitamin A in aqueous digitonin is about 45,600. Therefore in going from retinene to vitamin A, $E_{max.}$ is expected to rise $45{,}600/38{,}300 = 1{\cdot}19$ times. In Fig. 3, it rises 1·20 times. This simple procedure therefore completes in solution and quantitatively the sequence of reactions by which rhodopsin bleaches.

The final spectrum in Fig. 3 includes a very small 'tail' of absorption, maximal near 450 mμ. This is the artefact already mentioned, formed whenever rhodopsin is bleached in orange or red light.

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EVIDENCE FOR A REVERSIBLE FIRST-ORDER PHASE TRANSITION IN COLLAGEN – DILUENT MIXTURES

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THE view that thermal shrinkage in collagen is primarily a process of melting, though not widely accepted, is nevertheless supported by a variety of observations[1]. Transition from a predominantly crystalline to an amorphous state is indicated by the X-ray diffraction work of Astbury[2]. An increase in volume on shrinkage of water-swollen collagen has been reported by Weir[3] and in heat content by Küntzel and Doehner[4] and by Wöhlisch and de Rochemont[5]. Theis[6], Lennox[7], and others have observed that the temperature of the transition is lowered systematically by dilution. The shrinkage process has been variously described, however, as a degradation (or hydrolysis) to gelatin, or as a 'denaturation process' similar to the phenomenon of protein coagulation[8] rather than as a true phase transition. In this communication we report observations on the volume changes occurring during thermal shrinkage and recrystallization of collagen, which in our opinion offer convincing evidence of a phase transition appropriately characterized by a melting point.

Collagen was prepared from beef tendo achillis which had been extracted to remove globular proteins, fats, and certain of the mucopolysaccharides. After having been cut into sections 0·01 in. in thickness, it was dried to constant weight, and portions were swollen in ethylene glycol vapour to the desired concentrations by weight. 7- to 20-gm. samples were introduced into dilatometers of 0·50 mm. capillary radius, which were then sealed, evacuated, and filled with mercury as a confining liquid.

The filled dilatometers were heated rapidly to a temperature within three or four degrees of the transition temperature, T_m, after which the heating rate was reduced to three degrees per day. Equilibration was rapid above T_m. The liquidus was therefore established in a comparatively brief period, transformation to gelatin thus being avoided. Less than 5 per cent water-leachable material was found on removal of the sample from the dilatometer, indicating negligible formation of gelatin during the melting process.

The volume–temperature curves were found to resemble those for the melting of many crystalline copolymers and to exhibit a similarly broad melting range[9–12]. A typical plot is shown in Fig. 1 for the composition having a weight fraction of collagen, $w_2 = 0{\cdot}700$. The ordinate, Δy, represents the difference between the dilatometer scale reading observed for the melted sample (or calculated for that temperature assuming a linear liquidus) and the scale reading observed for the partly crystalline sample. The point at which Δy reaches zero, and hence at which melting is complete, should correspond to the melting point, in accordance with interpretations established for other polymer systems[13,14]. The 'rounding off' of the curve (Fig. 1) in this region is suggestive of copolymer melting[15].

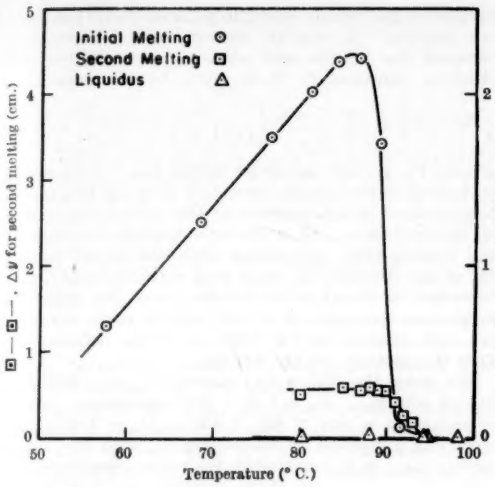

Fig. 1

When the more dilute samples were supercooled some fifteen to forty degrees below T_m, a slow recrystallization proceeded over a period of one or two days as evidenced by a small but unmistakable volume decrease of the order of magnitude of 10^{-4} c.c./gm. of collagen. Upon subsequent heating, re-melting occurred at the same temperature, T_m, observed initially, or at most a few degrees below it. Small discrepancies, when observed, are attributable to the formation at low recrystallization temperatures of crystallites which are less perfect than those existing in native collagen and hence melt at a lower temperature. Similar behaviour is commonly observed in other polymeric substances[16].

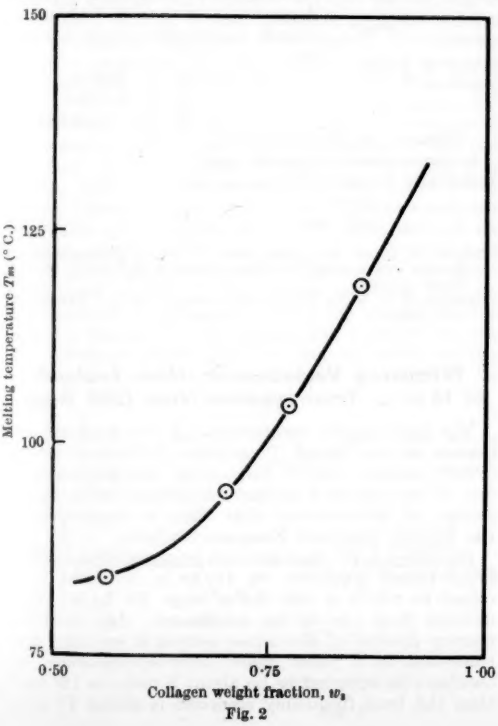

Fig. 2

An extrapolation of the curve shown in Fig. 2 to $w_2 = 1$ yields a value of about 145° C. for $T°_m$, the melting temperature of unswollen collagen. The heat, ΔH, and entropy, ΔS, of fusion of crystalline collagen may be calculated from the melting point depression by glycol, using procedures which have been successfully applied to phase transitions in other crystalline polymers[13,14,17]. The values so obtained are, respectively, 24 cal./gm. and 0·055 cal./deg./gm., where the density of collagen was taken to be 1·35 gm./c.c. The corresponding molar quantities per structural unit, derived from the average molecular weight of the collagen structural unit of 94 gm./mole, are 2,200 calories and 5·3 cal./deg. The former appears to be somewhat less than the value to be expected for the dissolution of one hydrogen bond per residue.

The number of bonds freed by melting to assume random rotational configurations may reasonably be estimated as two per residue. The entropy change per bond thus becomes 2·6 cal./deg./bond, a value somewhat higher than that observed for most other polymers. Such a value for the entropy indicates that a high degree of order exists in the crystalline regions and that the collagen molecule assumes a random configuration in the liquid state.

The volume–temperature behaviour of collagen thus exhibits the features characteristic of crystal–liquid transitions in other polymeric substances: a well-defined melting temperature which is determined only by the composition of the collagen – diluent mixture and is independent of the previous thermal history of the sample; a time-dependent recrystallization, suggesting the necessity for some sort of re-nucleation to precede crystalline growth, as has been found for polymers generally; and the virtual recovery after recrystallization of the initial melting temperature. The conformity of collagen to these criteria characterizing a phase transition suggests the further application to collagen and other fibrous proteins of methods previously applied successfully to the study of polymer crystallization.

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LETTERS TO THE EDITORS

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Absorption of 3·5-m. Radiation in the Optical Emission Nebula, NGC 6357

In the course of a radio survey of bright emission nebulæ with the 1,500-ft. Sydney cross-aerial, some fourteen nebulæ were studied at a wave-length of 3·5 m. Six were probably observed in emission, seven were undetectable, and one, *NGC* 6357, was observed in absorption. The observation of *NGC* 6357 is the first reported case of absorption of radio waves by an emission nebula; it leads to an estimate of the electron temperature of the nebula based almost entirely on radio data. In this preliminary communication the observation and its consequences are discussed briefly; a more complete account of the survey will be given elsewhere.

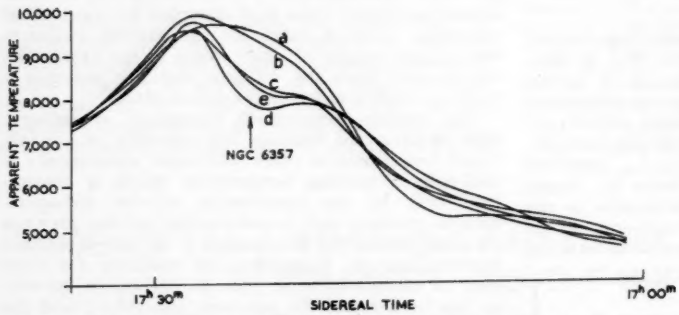

Fig. 1. Tracings of records obtained at five declinations superimposed to display the absorption effect at the position of *NGC* 6357. Declinations: (*a*) − 35° 11′; (*b*) − 34° 51′; (*c*) − 34° 31′; (*d*) − 34° 11′; (*e*) − 33° 51′

The radio telescope has a pencil-beam response, 50′ between half-power points, and is used as a transit instrument. It may be used to scan through a small angle in the meridian plane, recording five separate declinations quasi-simultaneously. In Fig. 1 are shown tracings of five such records straddling the nebula position and superimposed to display the effects of absorption. The position of the nebula is 17h. 18·4m., − 34° 03′ (1900), and the angular size is 63′ × 43′ [1]. Maximum absorption is estimated to occur at a position of 17h. 18·7m. ± 0·2m., − 34° 05′ ± 5′ (1900), in good agreement with the nebula position and in even better agreement with a radio measurement at 9·4 cm. by Haddock, Mayer and Sloanaker[2].

It is easily seen that the electron temperature of a mass of ionized gas observed in absorption must normally be less than the apparent brightness temperature at its centre (if both the nebula and background are irregular, with comparable scale factors, this is not necessarily true, but it appears safe to ignore such a possibility here). The brightness temperature at the nebula position is 7,800° K., with an estimated maximum calibration error of ± 20 per cent, or 1,600 deg. K. Thus the electron temperature of the nebula is probably less than 7,800° K. and almost certainly less than 9,400° K. An estimate of the actual temperature may be made if some other properties of the nebula and the galactic radio emission are known. It can be shown that if absorption between the nebula and observer is negligible, the electron temperature T_e is given by the equation:

$$T_e = T_a - (T - T_a)\left\{\frac{\Omega_0}{\Omega_n(1-\varepsilon^{-\tau})} - 1\right\} - \alpha D$$

where T_a is the apparent brightness temperature measured at the nebula position; T is the brightness temperature in the absence of the nebula, estimated by interpolation; Ω_0 is the equivalent solid angle of the nebula after smoothing with the aerial beam; Ω_n is the actual solid angle and τ the optical depth (assumed uniform) of the nebula; α is the apparent brightness temperature of the galactic radio emission per unit distance in the direction of the nebula, and D is the distance to the nebula.

We take the following values: $T_a = 7{,}800°$ K.; $T = 8{,}800°$ K.; $\Omega_n = 1{\cdot}9 \times 10^{-4}$ steradian (corresponding to a size of 63′ × 43′); $\Omega_0 = 3{\cdot}6 \times 10^{-4}$ steradian (obtained by smoothing Ω_n with the aerial beam); $\varepsilon^{-\tau} \approx 0$ (consistent with the measurements of flux density at 9·4 cm.); $\alpha \approx 0{\cdot}5$ deg. K./parsec (estimated from the integrated brightness through the galaxy); $D = 1{,}000$ parsecs (distance of the assumed exciting star, − 34° 11671).

The corresponding electron temperature is 6,500° K., which is of the same order as, but rather lower than, 10,000° K., the temperature usually assumed for such nebulæ; the value could be even lower if the nebula were 'patchy'. A quantitative optical study of the nebula might prove very interesting.

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Frequency Variations in New Zealand of 16 kc./s. Transmissions from GBR Rugby

We have made comparisons of the received frequency of the British Post Office Station at Rugby (*GBR*), distant 19,000 km., with the frequency of one of our standard crystal oscillators, following the receipt of information[1] that *GBR* is controlled by the British Standard Frequency source.

Equipment for this purpose consists of a narrow-band tuned amplifier on 16 kc./s. followed by a mixer to which is also fed a large 16 kc./s. signal derived from one of our oscillators. Any beat frequency present in the mixer output is recorded continuously on a paper chart. For convenience, our oscillator is adjusted to be about 3 parts in 10^7 fast; thus the beat frequency recorded is about 17 c./hr.

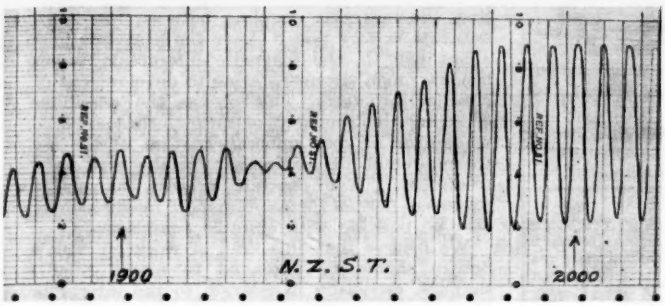

Fig. 1

Since the ratio of mean signal to peak noise of *GBR* at the receiving site is approximately − 20 db. for a bandwidth of 400 c./s., the beat frequency is passed through a low-pass filter with a cut-off frequency of 0·01 c./s. before being applied to the recorder, so that a high signal/noise ratio is maintained on the chart.

A sample record is shown in Fig. 1. It shows the beat frequency between *GBR* and our standard, the amplitude of the record being proportional to the amplitude of the signal received from *GBR*. The relative variations in frequency are derived from the number of cycles occurring in a given time. It is possible to determine the frequency of *GBR* in terms of the frequency of our own oscillator to within about one part in 10^9 in a 1-hr. period. However, our oscillator at times shows frequency variations greater than this.

Fig. 2 is a plot of the apparent frequency variations of *GBR* against our oscillator for the day on which the record of Fig. 1 was obtained, together with a plot of relative amplitude of the signal. On another day the received frequency about 1800 G.M.T. was observed first to increase above, and then decrease below, the mean frequency, although the magnitude of frequency shift was similar. At present the received frequency of *GBR* appears to be constant within the accuracy of measurement (4 parts in 10^9) over the periods 0900–1700 G.M.T. and 2100–0600 G.M.T.; but around 1900 and 0730 G.M.T.—the times at which the amplitude of the signal from *GBR* goes through its minima—there are marked changes in frequency of the order of 2 parts in 10^9. The portion of chart reproduced in Fig. 1 covers one of these periods. The accuracy of measurement in the steady periods may be limited by the short-term stability of our own oscillator rather than by the instability of the transmission path. The frequency of *WWVH* as received and measured at the same site[2] shows variations at least one order greater than those of *GBR*, both diurnally and over short periods.

Pierce, Mitchell and Essen suggest[1] the possibility of a world-wide basis for frequency comparison. We feel that our results are evidence for this possibility, and we hope to carry out long-term observations of *GBR* to that end, providing that the frequency control of *GBR* continues as at present.

We acknowledge the encouragement given to this work by Mr. W. H. Ward and the assistance of Mr. F. Ellis in instrumentation.

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Production of Self-Reversal of Thermo-remanent Magnetism by Heat Treatment of Ferromagnetic Minerals

It has been already reported by us[1] that the reverse thermo-remanent magnetism of the Haruna rocks is due to magnetic interaction between two different constituents of very small size in ferromagnetic mineral grains, which are mainly composed of ilmenite–hæmatite solid solutions. The production of reverse thermo-remanent magnetization of the Haruna and the similar rocks can be intensified by suitable heat treatment of the samples. This is illustrated in the upper and middle diagrams in Fig. 1.

The samples examined here are the ferromagnetic minerals separated out from the Haruna rock (upper diagram) and the Sokota rock (middle diagram). Both these minerals are mainly ilmenite and hæmatite solid solutions, the Curie points of which range from 100° C. to 320° C. When these samples are kept for a time at about 680° C. in the atmosphere and then quenched to room temperature, their reverse thermo-remanent magnetism becomes markedly increased. In Fig. 1, the abscissa shows various temperatures at which the heat treatments were carried out and the ordinates the intensity of total thermo-remanent magnetism that was acquired by cooling from 400° C. in the geomagnetic field after the heat treatment. The full lines in these diagrams represent the result of the heat treatment during 10 min. at the respective temperatures, while the broken lines show the final result of the same heat treatment maintained for a sufficiently long time. It is clear that the heat treatment at about 680° C. is most effective for intensifying the reverse thermo-remanent magnetism, and that these samples become

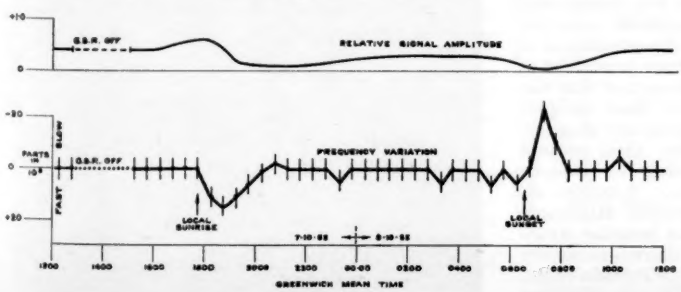

Fig. 2

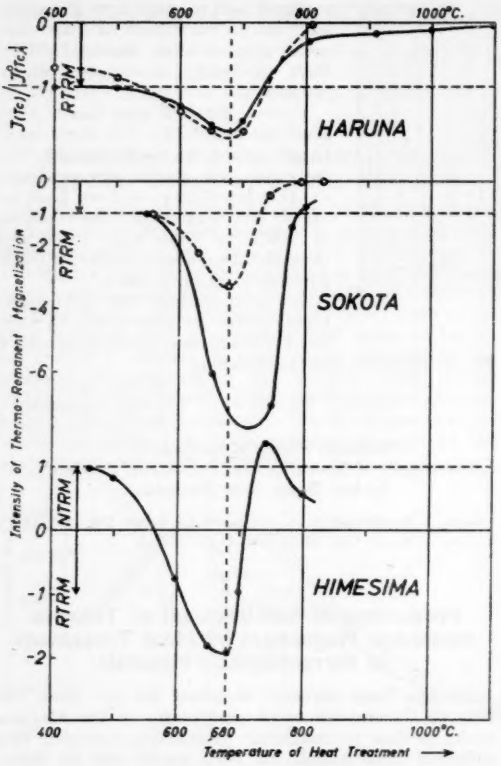

Fig. 1. Total thermo-remanent magnetization, $J(T_0)$, of ferromagnetic minerals after heat treatments at various temperatures in units of the intensity of total thermo-remanent magnetization of their original state, $J^0(T_0)$

magnetically unstable in the atmosphere at temperatures higher than about 850° C.

The same heat treatment procedure was applied on the ferromagnetic minerals separated out from Himesima rocks, which also are mainly composed of ilmenite–hæmatite solutions, their Curie points ranging from 230° C. to 250° C., but which show only the normal thermo-remanent magnetization in their original state. The result of heat treatments of this sample is illustrated in the lower diagram in Fig. 1. This shows clearly that the heat treatments at temperatures of 600°–700° C. result in the definite characteristic of the reverse thermo-remanent magnetism, the effect being a maximum again at about 680° C.

The composition of these samples was determined by chemical, magnetic and X-ray analyses, and the electron-microscope examination of fine structures of these samples before and after the heat treatment is now proceeding. Preliminary results suggest that the heat treatment at about 680° C. of these samples results in growth of the lamellar structure of intergrowth of two constituents, so that their mutual interaction becomes sufficiently strong to produce reverse thermo-remanent magnetism. Actually, an electron-photomicrograph of the original Himesima minerals showed the presence of the lamellar structures[2], but their characteristic thermo-remanent magnetism is just the same as that of Towada rock[3], namely, positive superposition of thermo-remanent magnetizations of the two constituents, suggesting that the magnetic coupling between the two constituents is very poor. After the heat treatment at about 680° C., the magnetic interaction seems to become much stronger, owing to development of the lamellar structure. This proves the possibility of changing the property of normal thermo-remanent magnetism of rock minerals to that of the reverse thermo-remanent magnetism by the artificial heat treatment. The opposite process, namely, from reverse to normal thermo-remanent magnetism, might also be possible with suitable conditions.

We believe that this kind of work on rock magnetism should be extended to many other rock samples, especially in relation to the interpretation of magnetic orientation of rocks for the purpose of palæomagnetism.

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Correlation Patterns in the Chromospheric Granulation

Uberoi[1] has recently discussed a simple method of measuring the spatial correlation of the brightness fluctuations between neighbouring regions in the solar photosphere. He pointed out that, if two identical enlargements of a photograph of the solar photosphere are superimposed and one rotated from the matched position, the product of the outer radius of the circular pattern then visible and the angle of rotation gives a measure of the distance, beyond which the correlation becomes insignificant.

We have applied this technique to study chromospheric granulation using photographs taken in $H\alpha$ with a Lyot monochromator of band-width 0·7 A. Fig. 1 shows the circular correlation pattern produced

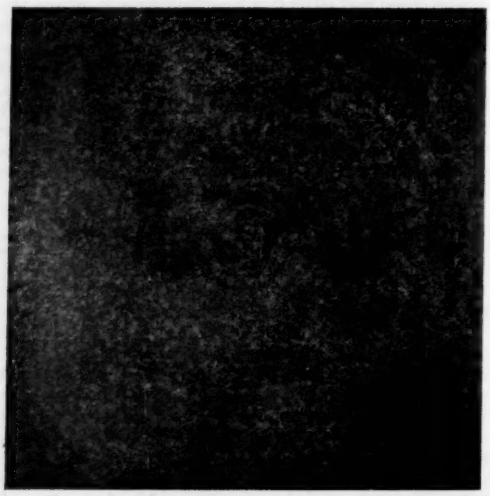

Fig. 1

from two enlargements of a chromospheric photograph taken on December 7, 1954, at 5h. 13m. U.T., this being a day of low solar activity. It is evident that the pattern shows no marked asymmetry. The correlation is found to become insignificant at distances greater than about 3×10^4 km., which agrees closely with the mean linear dimension of the larger elements of the chromospheric fine structure as estimated from the original photograph.

Because of the relatively long life-time of the chromospheric fine structure, it is also possible to obtain correlation patterns from photographs taken up to several hours apart. A preliminary study of the decrease in the correlation distance as the interval between the photographs is increased has led to the conclusion that the correlation is not very pronounced after a period of five to six hours.

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Absorption of Ultrasound in Light Gases

Numerous workers during the past thirty years have made measurements of the absorption of ultrasound in the lighter gases (that is, oxygen and gases of lower density). The majority of the workers used interferometric techniques developed from that described by Hubbard[1]; a smaller group used optical methods[2]. An examination of absorption values obtained for the lighter gases shows that both the discrepancies between results of different workers and the range of results of individual workers are such that it is difficult to deduce any reliable data: few give any estimate of the possible errors in their results. Although Pumper[3], Krasnooshkin[4] and Bell[5] have shown that the acoustic interferometer may produce anomalous results, due to effects not previously considered, this fact has apparently not been fully appreciated. It would seem that the best published results using these techniques cannot be relied upon to better than ± 20 per cent.

Recent measurements of absorption in nitrogen and oxygen in the frequency-range 60–70 kc./s. by Parker, Adams and Stavseth[6], using a direct transmission pulse system, appear to be more reliable.

We have developed a pulse method for measuring the absorption directly at 1 Mc./s. (over a pressure-range of 0·2–2·0 atm.) which yields results to an estimated accuracy of ± 5 per cent for a single measurement. Since the major errors in the method are random, the usual statistical techniques can be used to obtain values to a higher accuracy.

Measurements in oxygen show that the absorption coefficient is 1·240 ± 0·025 times the 'classical' Stokes–Kirchoff value[7], while in nitrogen the absorption is 1·235 ± 0·015 times 'classical'. These values agree well with 1·19 ± 0·05 for oxygen and 1·22 ± 0·07 for nitrogen obtained by Parker, Adams and Stavseth[6].

All the 'error' values quoted above are the 1 per cent limits of a normal distribution.

The technique is being further developed for measurements of both absorption and velocity at frequencies up to 20 Mc./s.

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Electrochemistry of Stainless Steel in Sulphuric Acid

In a study of the electrochemical behaviour of stainless steels, the electrode potential has been continuously recorded during the transformation of an air-stable oxide film to the surface state that exists in dilute, aerated sulphuric acid at temperatures between 25° and 90° C. Several definite inflexions or stages in the process have been observed which are similar in certain respects to the oscillograms obtained by Bonhoeffer and Vetter[1] in the activation and re-passivation of carbon steel in nitric acid. With stainless steel, the processes are much slower than those observed with carbon steel, so that the details of the several stages may be more readily studied. Thus, Fig. 1 shows the results obtained at 85° C. when a niobium-stabilized steel (type 347) was heated in air at 445° C. for 2 hr. and then placed in an aerated 0·1 *N* mixture of sulphuric acid and sodium sulphate which had a *p*H of 1·46. A vibrating-reed electrometer measured the potential between the steel electrode and a reference electrode kept at 24° C., so that all potentials to be given include a small potential due to the thermal gradient in the bridge. Dissolved iron was determined at intervals spectrophotometrically by use of thioglycollic acid[2].

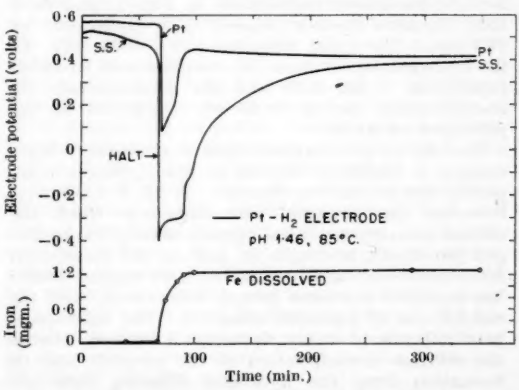

Fig. 1. Potential-time curves for stainless steel (S.S.) and smooth platinum (Pt) electrodes in aerated sulphate solution. The dissolution curve is also shown. The potential of a platinized electrode in a hydrogen atmosphere under otherwise the same conditions is indicated at − 0·3 V.

A barely detectable amount of iron dissolved during the initial passive phase. During the slow debasing, the colour became paler, and a sudden large drop in potential followed the disappearance of the last visible film, with a brief inflexion around 0 mV. versus the saturated calomel electrode (S.C.E.) as this occurred. This phase corresponds to the 'reductive-dissolution' studied by Pryor and Evans[3]; its completion left very active metal exposed and the potential fell to about − 400 mV.

From its minimum value the potential rose slightly while corrosion proceeded rapidly. What followed next was dependent upon a combination of factors which include the corrosion resistance of the specimen, the acidity, the temperature, the partial pressure of oxygen, and the geometry of the system with respect to the availability of oxygen at the interface. Fig. 1 illustrates the changes observed when using conditions that resulted in spontaneous recovery to a noble potential. Characteristically, the abrupt ennobling always began close to − 295 mV.; this point we have designated the 'critical recovery potential' for the conditions specified. The ennobling was interrupted by a brief inflexion in the region of − 140 to 0 mV., beyond which the potential rose slowly until it approached the potential indicated by a smooth platinum wire in the same solution. The ennobling process was found to be accelerated by iron (III) and copper (II) ions, among others, and experiments with radioactive iron and copper showed that both went into the film that formed during this stage of the process.

Certain specimens did not become ennobled spontaneously under the conditions indicated. In such cases, it was possible to induce the ennobling process artificially by (*a*) increasing the partial pressure of oxygen, (*b*) lowering the temperature, (*c*) raising *p*H, (*d*) adding a very small amount of an oxidizing agent such as ferric ions, cupric ions or hydrogen peroxide, or (*e*) applying briefly a small positive polarizing potential. In all such cases, if the stimulus was adequate but sufficiently small, the critical recovery potential was observed as before. Whenever, and for whatever cause, the sample passed the critical recovery potential, corrosion dropped suddenly to a very low value, as shown by the iron dissolution curve in Fig. 1.

The empirical hydrogen potential was determined for the conditions represented in Fig. 1, and at a total pressure (water vapour plus hydrogen) of 740 mm. The value obtained was − 300 mV. In the hydrogen atmosphere the stainless steel corroded rapidly at − 400 mV. and the corrosion-rate increased when the electrode was connected to the platinized electrode.

So long as the corrosion-rate is sufficiently high, oxygen is unable to depolarize the hydrogen completely and oxidize the interface. If dE/dt is positive, however, the potential will ultimately reach the critical recovery potential (approximately the hydrogen potential), hydrogen in and on the metal now becomes anodic, and by reaction with oxygen doubtless goes into transient peroxy compounds, with the sudden rise of potential observed. The subsequent brief inflexion probably represents a balance between the thermal decomposition of the peroxide and its formation from the hydrogen diffusing from the interior of the metal.

The experiments give a clear meaning to the measurements of Edeleanu[4], who found that an 18–8 stainless steel had a maximum corrosion-rate in 20 per cent sulphuric acid at 25° C. when held at a potential of about − 250 mV. Upon duplicating his experimental conditions, the 'empirical' hydrogen potential was found to be − 217 mV. Clearly, the maximum corrosion-rate should occur when the depolarization by oxygen or by an applied potential is as nearly complete as it can be without raising the electrode to the hydrogen potential. If it goes higher, hydrogen ions cease to be reduced, thereby permitting the spontaneous ennobling by reduction of oxygen.

Fuller details of this work, which was done for the U.S. Atomic Energy Commission, will be published elsewhere.

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Purification of a Metal by Zone-refining one of its Salts

The technique of zone refining has been applied very successfully to the purification of metals and elements[1], especially in the semi-conductor field where very high purity is essential. With some elements, however, it happens that certain impurities have segregation coefficients (ratio of solid to liquid solubility) of the order of unity, and consequently are not swept efficiently by the molten zone.

In general, it may be possible to overcome this difficulty by carrying out the zone-refining process not on the element itself but on some suitably chosen salt (or compound) in which better segregation may be obtained. It would be necessary to choose a salt which crystallizes readily and has a convenient melting point. It must also be such that the metal can be recovered readily and without risk of re-contamination.

This technique has been successfully applied to the purification of gallium. Zone-refining of the metal was not effective, as will be seen by comparing the first two columns of Table 1. The experiment was then tried of zone-refining the trichloride, which is a clear crystalline solid with a melting point of 75° C. The trichloride was formed by direct reaction of the gallium with commercial chlorine. Twenty passes of a liquid zone through an ingot of this material gave visible purification, the front end becoming transparent and practically single-crystal, whereas the rear end became highly discoloured and poly-

Table 1. Spectrographic Analysis of Impurities found in Gallium

Impurity	Gallium as purchased (parts in 10^6)	After zone-refining gallium metal: 40 zone passes (parts in 10^6)	After zone-refining gallium trichloride: 20 zone passes (parts in 10^6)
Cu	20	20	
Fe	70	60	
Ca	20	10	No trace
Mg	20	20	(Limit 1 in 10^6)
Si	70	70	
Al	10	5	
Ag	10	5	

crystalline. The clear end was cut off and dissolved in demineralized water and the metal then recovered by electrodeposition. More than 80 per cent of the metal could be recovered in this way. Spectrographic analysis of this material showed no trace of impurities, the approximate limit of detection, as determined by control experiments, being 1 in 10^6. That the electrodeposition by itself was not effective in the purification had been shown by earlier experiments.

The spectrographic work was carried out by N. Rain, of this Laboratory. Acknowledgment is made to the Admiralty for permission to publish this communication.

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The Lupulone and *iso*Humulone Complex

At about the same time that we announced the existence of prehumulone[1], the presence of a fourth lupulone in hops was suggested by Howard, Pollock and Tatchell[2]. The present communication gives chromatographic proof of the existence of such a substance, which we propose to call 'prelupulone'. This chromatographic separation of the lupulone fraction of hops into its four components has been achieved by the technique described by us for the chromatography of the 'humulone complex'[1]. This is shown in the elution pattern of Fig. 1, which was obtained on a silica gel column, 1·3 cm. × 123 cm., buffered at *p*H 10·55 and containing 25 per cent methanol. The four bands were named in accordance with present knowledge of humulone chemistry[1,3].

When the 'lupulone complex' is recrystallized, the percentage of colupulone in the crystals thus obtained (still a mixture of several lupulones) is higher than in the starting material. This is probably due to the lower solubility of colupulone. It is therefore possible by repeated crystallizations (about five times from light petroleum and five times from methanol–water) to obtain pure colupulone with a melting point of 94°–96° [3]. Chromatography of this product on the column mentioned above yields a single band, corresponding exactly with the colupulone band of Fig. 1.

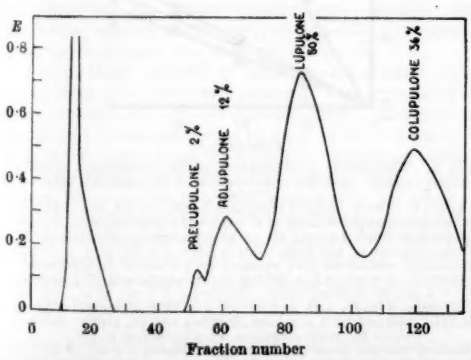

Fig. 1. Chromatography of the 'lupulone complex'. Volume of each fraction 4·5 ml. E(1%, 1 cm.) lupulone in *iso*-octane = 159 (λ = 275 mμ)

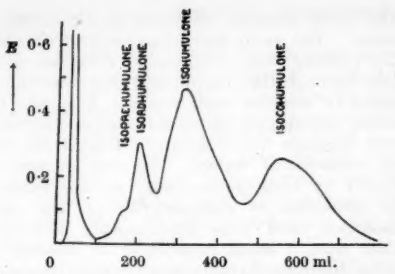

Fig. 2. Chromatography of the '*iso*humulone complex'. Volume of each fraction 6 ml. E(1%, 1 cm.) *iso*humulone in *iso*-octane = 275 (λ = 275 mμ)

The presence of an *iso*prehumulone in a beer extract can also be shown by chromatography. This separation is not as successful as for the humulone and lupulone complex, owing to extensive overlapping of the bands. An example of such a separation on a silica gel column 1·3 cm. × 85 cm., buffered at *p*H 5·22 and containing 25 per cent methanol, is shown in Fig. 2.

The beer *iso*humulone mixture for chromatographic analysis is obtained by extracting acidified (*N* sulphuric acid) beer with 2·5 times its volume of *iso*-octane. When this volume ratio is used, practically no emulsion is formed and centrifuging can be avoided. The *iso*-octane is evaporated under reduced pressure before chromatography.

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Adsorption of Trace Amounts of Cations on Anion Exchange Resins by the Formation of Insoluble Salts

It has been shown[1] that cations may be precipitated around the beads of an anion exchange resin in a column, when passed in aqueous solution through the resin, which is in a form providing a suitable anion. For example, when a cobalt solution is used with a resin in the sulphide form, cobalt sulphide is formed around the beads of resin. The nature of these precipitates suggested that fairly high concentrations of precipitating anion were present in the region of the surface of the resin particles.

It seemed likely that the anion concentration within a bead of resin might be extremely high and that a very small amount of a cation in aqueous solution, diffusing into the resin, might be precipitated in the resin itself. This hypothesis was tested by passing carrier-free radioactive isotopes down columns of anion resin in suitable forms. The behaviour of these tracers was related to the solubility of the compounds concerned and to the formation of soluble complex ions.

A column, 40 cm. long and 0·3 cm. in diameter, was packed with 'Amberlite *IRA* 400' anion resin (60–85 B.S. mesh-size). The amount of resin used was calculated to have a five-fold excess of capacity

over the total amount of anion to be added with the tracer. The resin was converted to the desired form by passing large volumes of solutions of acids or alkalis through the column and then washing away the excess of reagent with water. A small volume of solution containing the tracer cation (carrier-free) was run through the column, followed by several column volumes of water. The fate of the cation was found by radioactive assay of the eluate and by the detection of radioactivity on the column. The isotopes used were cæsium-137, strontium-89 (together with a small proportion of strontium-90), zirconium–niobium-95 and cerium-praseodymium-144.

In some preliminary experiments, a column in the hydroxide form allowed strontium and cæsium to run through but collected quantitatively the zirconium–niobium mixture; an oxalate column retained most of the strontium and no cæsium; and a carbonate column collected strontium. Some systematic experiments were then carried out to relate behaviour with solubility and gave the following results:

Cation	Resin form	Solubility (gm./l.)	Behaviour of cation
Cs^+	NO_3^-	190	Unabsorbed
Cs^+	ClO_4^-	20	Unabsorbed
Sr^{++}	OH^-	17·4	Unabsorbed in most experiments
Sr^{++}	$CrO_4^=$	1·5	About 20 per cent unabsorbed, the rest strongly absorbed
Ce^{+++}	$C_2O_4^=$	0·53	Absorbed
Sr^{++}	$C_2O_4^=$	0·05	Most of the cation absorbed

These results suggest that compounds with solubilities of 1·5 gm./l. or less can be used for the collection of their respective cations in this way. In all cases the cations were readily washed off the resin by dilute acid.

The strontium results were particularly interesting. As hydroxide, the strontium was held on the resin in a few experiments but not in most of them. This was believed to be due to the solubility of strontium hydroxide being very near the limit for collection, so that the behaviour depended on temperature, rate of elution and possibly the presence of other ions in solution. With chromate and oxalate columns the strontium was split into two forms, one of which was quickly eluted, and the other which was retained firmly on the resin. This is believed to be due to the relatively high concentration of nitrate ions in the tracer solution (the strontium-89 was used in nitric acid solution); these ions liberated appreciable amounts of chromate and oxalate ions from the resin, which in turn gave rise to small amounts of soluble association complexes with the otherwise insoluble strontium compounds. This was confirmed when the strontium tracer was stirred with a small quantity of anion resin in the hydroxide form to reduce the total anion concentration before passing down the oxalate column, when all the strontium was retained by the resin.

Since the strontium concentration was about 1×10^7 disintegrations/min./ml., the effective concentration of, for example, chromate ions in the resin necessary to 'precipitate' the strontium would be about 1×10^4 *M*. It is more likely, therefore, that the high concentration of chromate ions in the resin promotes the formation of a radio-colloid, which is then adsorbed on the resin.

This method of collecting cations in trace concentrations has the advantages of being more efficient and more selective than the conventional co-precipitation technique. It is now being used for rapid separations of individual fission products from mixtures, and may also be used for forecasting the insoluble compounds of elements of which only trace amounts are available.

We thank E. F. Kemp for a helpful discussion, and the Managing Director, U.K. Atomic Energy Authority (Industrial Group), for permission to publish this communication.

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Effect of Copper Cyanide upon the Formation *in vitro* of Melanin

As already reported, copper–xanthopterin accelerates the autoxidation of 3,4-dihydroxyphenylalanine[1]. In the course of further work, we have observed some interesting effects with cupric ions.

When potassium cyanide was added, in order to capture copper, to the solution containing the copper–xanthopterin and dihydroxyphenylalanine, the oxygen uptake was much enhanced and rapid formation of melanin was brought about. Such a result was not expected at first, for it is generally known that copper oxidases are inhibited by cyanides. We then found that the copper cyanide acted catalytically upon the autoxidation of dihydroxyphenylalanine, showing a rate of oxygen uptake as high as 70 µl. per hr., in contrast with 48 µl. consumed by the system containing copper–xanthopterin and dihydroxyphenylalanine.

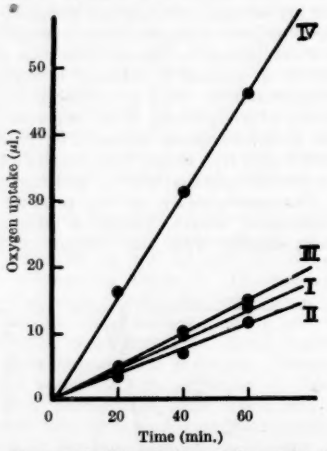

Fig. 1. Manometric determination of the accelerating effect of copper cyanide upon the autoxidation of pyrocatechol (*p*H 7·8, 37·5° C.).

Curve IV: 1·0 ml. of *M*/15 phosphate buffer, 1·0 ml. of 5×10^{-4} *M* potassium cyanide, 0·5 ml. of 5×10^{-4} *M* cupric sulphate, 0·3 ml. of distilled water and 0·5 ml. of 10^{-2} *N* sodium hydroxide in the main chamber of the flask. Curve III: 1·0 ml. of 5×10^{-4} *M* potassium cyanide in (IV) replaced by 1·0 ml. of distilled water. Curve II: 0·5 ml. of 5×10^{-4} *M* cupric sulphate in (IV) replaced by 0·5 ml. of distilled water. Curve I: 1·0 ml. of 5×10^{-4} *M* potassium cyanide and 0·5 ml. of 5×10^{-4} *M* cupric sulphate in (IV) replaced by 1·5 ml. of distilled water. Other components in the main chambers are all common to (IV).

Each of the side arms of the flasks contained 0·5 ml. of 10^{-3} *M* pyrocatechol in 10^{-3} *N* hydrochloric acid, and each of their wells, 0·2 ml. of 10 per cent potassium hydroxide. The gas space of the manometric flask was filled with air. The pyrocatechol solution was tipped from the side arm into the main chamber when the flask reached thermal equilibrium

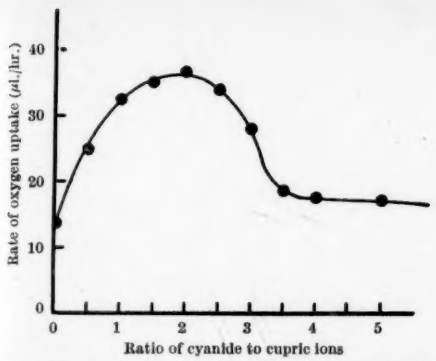

Fig. 2. Manometric determination of the effect of the mixing ratio of potassium cyanide to cupric sulphate upon the catalysis of the autoxidation of pyrocatechol (*p*H 7·8, 37·5° C.). Each of the experimental flasks contained 0·2 ml. of 5×10^{-4} *M* cupric sulphate, 0·1 ml. of potassium cyanide of various concentrations ($0{\cdot}5 \times 10^{-3}$ *M*, 1×10^{-3} *M*, $1{\cdot}5 \times 10^{-3}$ *M*, 2×10^{-3} *M*, ..., 5×10^{-3} *M*), 1·0 ml. of *M*/15 phosphate buffer, 0·5 ml. of 10^{-2} *N* sodium hydroxide, and 1·0 ml. of distilled water in the main chamber. In the control flask, 0·1 ml. of potassium cyanide was replaced by 0·1 ml. of distilled water, all the other components being the same as those in the experimental flasks. Each of the side arms of the flasks contained 0·5 ml. of 10^{-3} *M* pyrocatechol dissolved in 10^{-3} *N* hydrochloric acid, and each of the wells, 0·2 ml. of 10 per cent potassium hydroxide. Other conditions were the same as those in the experiment shown in Fig. 1. The oxygen uptake per hour in the experimental, as well as control, flasks was plotted against the concentration ratio of potassium cyanide to cupric sulphate

In an earlier paper[2], it was shown that the accompanying xanthopterin checked the accelerating effect of cupric ions upon the autoxidation of pyrocatechol. There was, however, a remarkable production of the black pigment. Now copper cyanide, though it accelerates considerably the rate of autoxidation of pyrocatechol as well as dihydroxyphenylalanine, is not very superior to cupric ions alone as regards catalytic activity on pigment formation from pyrocatechol. In these ways at least, copper cyanide seems to differ considerably from copper–xanthopterin, probably in its mode of action toward the autoxidation processes.

As seen in Fig. 1, the cupric ion slightly accelerates, whereas the cyanide inhibits, the autoxidation of pyrocatechol. Nevertheless, the addition of both cupric ions and cyanide resulted in a definite acceleration of autoxidation. We then examined the effect of altering the ratio of copper to cyanide and found, as shown in Fig. 2, that the ratio 1 : 2 gave the maximum acceleration. It was also found that the addition of ethylenediamine, xanthopterin and certain other chelating agents to the copper cyanide–pyrocatechol system decreases the rate of oxidation.

From these results it was thought that certain complexes of copper and cyanide were produced and they acted more or less catalytically. This was also suggested by the stepwise change of the colour of the cupric sulphate solution with the increasing addition of potassium cyanide: from pale blue, through green, greenish-brown, and orange-red, to dark red. The cupric cyanide complex is known to be unstable[3].

The solution of copper and cyanide becomes more and more alkaline with the increase of the latter, but maximum activity in accelerating oxygen uptake, as mentioned above, occurs with a mixing ratio of 1 : 2. This suggests that the active species contains co-ordinated with it not more than two cyanide ions. As regards copper–xanthopterin, the optimal mixing ratio is 1 : 1 (unpublished work). From the optimal mixing ratios of these complexes, their substrate may be the bidentate donor derived from pyrocatechol and its derivatives[4].

Other substances such as thiocyanate and ammonia, when added to the cupric sulphate solution, affected the autoxidation of dihydroxyphenylalanine similarly to cyanide, although their activities were much lower. The order of the activity was $CN \gg CNS \gg NH_3$. Bivalent metallic ions other than cupric were investigated also; but if mixed with cyanide or thiocyanate or ammonia, they did not accelerate the autoxidation of either pyrocatechol or dihydroxyphenylalanine.

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Quantitative Determination of Acetylcholinesterase Activity in Individual Nerve Cells

Most of our knowledge concerning the topical distribution of cholinesterases in the mammalian nervous system is derived from studies on tissue sections by various histochemical methods. In order to obtain more detailed information about the localization of this enzyme in the neurone, a modified thiocholine method[1] has now been applied to single cells dissected out from living tissues[2]. Quantitative data regarding the cholinesterase contents in individual nerve cells are, however, still lacking.

In 1937, Linderstrøm-Lang introduced a microgasometric method based on the principle of the Cartesian diver[3]. Later, the diver technique was applied to studies on cholinesterase and proved useful in analysing small samples of blood[4], embryonic tissue extracts and tissue sections[5]. Recently, a micro-diver technique has been developed for cholinesterase measurements in single megakaryocytes of the bone-marrow of the rat (Zajicek and Zeuthen, unpublished work), and the method was refined further for studying the increase of the specific cholinesterase or acetylcholinesterase activity during the maturation process of megakaryocytic cells (Zajicek, unpublished work). The present communication reports the application of the micro-diver technique for the determination of the acetylcholinesterase contents in a single nerve cell.

Albino rats, weighing about 200 gm., were killed by decapitation without anæsthesia. The spinal, sympathetic and parasympathetic ganglions were isolated and placed in substrate-bicarbonate Ringer's solution. Individual nerve cell bodies and a part of their neurites 100–200μ long were dissected out by micromanipulation. The divers were charged and a 7×10^{-3} *M* solution of acetylthiocholine was used as substrate (Zajicek and Zeuthen, unpublished work). The esterase activity was expressed as the amount of carbon dioxide evolved from the

bicarbonate buffer by the acid formed during the enzymatic hydrolysis of acetylthiocholine. The sensitivity of the divers employed was of the order of 2×10^{-6} µl. carbon dioxide.

The esterase activity curves for a cell body, isolated from a sympathetic ganglion (filled circles) and that of its neurite (open circles) are given in Fig. 1. This graph shows that the cell body liberated about 620×10^{-6} µl. carbon dioxide, and a part of its neurite 130µ long 235×10^{-6} µl. carbon dioxide per hour, corresponding to the hydrolysis of about $7{\cdot}6 \times 10^{-3}$ µgm. and $2{\cdot}9 \times 10^{-3}$ µgm. of acetylthiocholine respectively.

Recent findings on the different types of cholinesterases indicate that acetylcholinesterase is the physiologically important enzyme in splitting acetylcholine in the animal system[6]. When measuring the enzymic activity in a single cell, the differentiation between cholinesterase and acetylcholinesterase cannot be achieved by current substrate specificity or activity-substrate concentration relationship tests for reasons discussed in detail elsewhere.

It has recently been found that 8×10^{-7} *M* mipafox (*bis*-mono*iso*propylamino-fluorophosphine oxide) completely inhibits the non-specific serum cholinesterase, whereas it affects acetylcholinesterase activity only in concentrations higher than 6×10^{-6} *M* [7].

The quantitative determination of non-specific cholinesterase and acetylcholinesterase activity in a single cell with the aid of the inhibitor involves three main steps: (i) the determination of the whole acetylthiocholine-splitting capacity of the cell; (ii) the introduction of a 6×10^{-6} *M* solution of mipafox which inhibits the non-specific cholinesterase into the diver; (iii) the subsequent measurement of the acetylcholinesterase activity (Zajicek, unpublished work).

The esterase activity curves of a cell body isolated from a spinal ganglion (crosses) and of a 100-µ long part of its neurite (filled circles), and, finally, of a sample of purified serum cholinesterase, before and after treatment with mipafox (open circles), are shown in Fig. 2. The graph shows that the cell body and its neurite, which hydrolysed 17×10^{-3} and $1{\cdot}5 \times 10^{-3}$ µgm. of acetylthiocholine per hr., respectively, exhibited the same esterase activity after

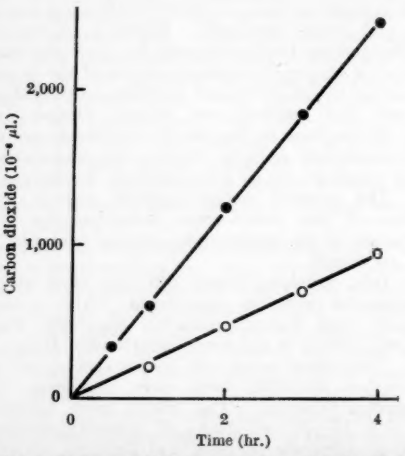

Fig. 1. Esterase activity curves of a cell body (37µ) isolated from a sympathetic ganglion of rat (filled circles) and that of a 130-µ long part of its neurite (open circles)

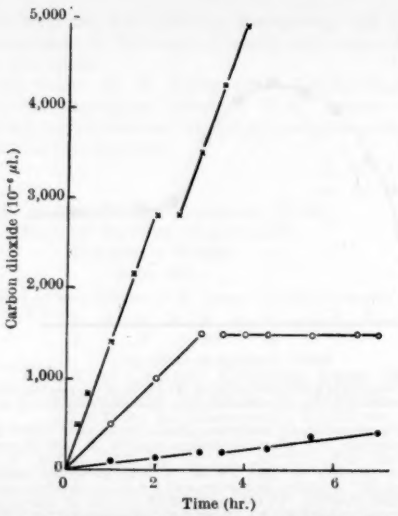

Fig. 2. Esterase activity curves of a cell body (44µ) isolated from a spinal ganglion of rat (crosses), of a 100-µ long part of its neurite (filled circles) and of a sample of purified serum cholinesterase (open circles), before and after treatment with mipafox

treatment with mipafox as before treatment, whereas the non-specific cholinesterase was completely inactivated by the inhibitor. It is therefore concluded that the esterase estimated in the single spinal ganglion cell was an acetylcholinesterase ('specific' or 'true' cholinesterase), that is, the enzyme which is claimed to be connected with the mechanism of the transmission of nerve impulse[6].

A detailed report of the inter- and intra-cellular distribution of acetylcholinesterase in ganglion cells will be published later.

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An Unidentified Amino-sugar present in Cell Walls and Spores of Various Bacteria

A substance reacting as a hexosamine but which is not glucosamine or galactosamine has been found in 6 *N* hydrochloric acid hydrolysates of a variety of bacterial cell walls by Cummins and Harris[1] and in peptides isolated from spores of *Bacillus megatherium*, *B. subtilis* and *B. cereus* by Strange and Powell[2]. There is evidence that in all cases the same substance is involved, and recently in this laboratory a similar compound was isolated from acid hydrolysates of cells of *Micrococcus lysodeikticus* in sufficient quantity

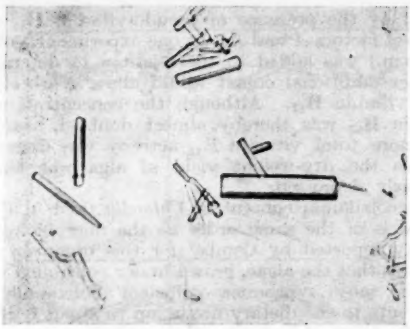

Fig. 1. An unidentified amino-sugar from *B. megatherium* spore peptide, crystallized from ethanol–water. × 100

for comparison with that from spore peptide, which showed that it was identical in a number of properties. The amino-sugar would therefore seem to be widely distributed in bacteria. The base has now been obtained in crystalline form from acid hydrolysates of spore peptide (Fig. 1) by the use of ion-exchange resins. Investigation of the crystalline compound has shown that it is not a simple hexosamine; for example, after treatment with ninhydrin according to the method of Stoffyn and Jeanloz[3], followed by paper chromatography, a spot was obtained which reacted with aniline phthalate[4] and other sugar spray reagents like a pentose but which had an R_F value considerably lower than that of arabinose, lyxose, xylose or ribose. This product reduced ammoniacal silver nitrate but did not react with naphtho-resorcinol–trichloracetic acid[5].

So far, the amino-sugar has always been found in the presence of glucosamine or glucosamine and galactosamine[1,2], and since it reacts like them in three methods for their estimation, namely, those of Elson and Morgan[6], Dische and Borenfreund[7] and Tracey[8], it will be estimated with them as hexosamine. It was thought desirable to determine the quantitative effect of the substance in these three methods. The crystals were dried over phosphorus pentoxide *in vacuo* at 60°.

Using the Immers and Vasseur[9] modification of the Elson and Morgan method, the colour obtained had an absorption maximum near 520 mμ, compared with that of 530 mμ for the glucosamine or galactosamine derivatives[2]. The relationship between light absorption at 520 and 530 mμ and concentration, for the substance and glucosamine (base), is shown in Fig. 2. When the light absorption of both derivatives was measured at 530, 520 and 510 mμ, the colour produced by the amino-sugar was equivalent to 56, 69 and 77 per cent, respectively, of that produced by an equal weight of glucosamine.

Using the Dische and Borenfreund method, the light absorption of the colour produced measured at 492 mμ minus that measured at 520 mμ was 53 per cent of that produced by an equal weight of glucosamine (base).

Using the Tracey alkaline distillation method, the ammonia liberated from the substance was equivalent to 5 per cent nitrogen compared with 7·8 per cent for glucosamine (base).

From these results it is evident that the substance cannot be estimated as a hexosamine with reference to glucosamine unless the conversion factor is known for each method. A simple method of detecting it is to take readings of the absorption of the Elson and Morgan colour at 510 and 530 mμ. The ratio $\frac{-\log T\ 530\ m\mu}{-\log T\ 510\ m\mu}$ is greater than 1·1 for the glucosamine and galactosamine derivatives and less than 0·9 for the amino-sugar derivative. It is also possible, by means of this ratio, to detect it in solutions containing these hexosamines, providing its concentration with respect to them is high enough.

For the estimation of the substance in the presence of glucosamine or galactosamine, advantage may be taken of the fact that the ion-exchange resin 1*R*–120 (H) (obtainable from B.D.H., Ltd.), buffered to *p*H 6·05, will remove these hexosamines but not the amino-sugar from aqueous solution. A column of 1*R*–120 (H) was prepared and *M* sodium dihydrogen and disodium phosphate buffer, *p*H 6·05, passed through until the eluent was at this *p*H. The resin was washed with de-ionized water until the eluent was free from phosphate and dried at room temperature on filter paper. The solution for analysis was adjusted to *p*H 6·0; in the case of acid hydrolysates, this was achieved by the use of 1*R*–4*B* (OH). The solution was diluted, if necessary, to contain not more than 100 μgm./ml. hexosamine-reacting material (as glucosamine). A sample (5 ml.) was treated with buffered resin (approximately 1 gm.) in a stoppered tube on a rotary shaker for 30 min. The solution was filtered free from resin through a Whatman No. 1 filter paper (5·5 cm.) and the Elson and Morgan reaction carried out with an aliquot of the filtrate (1–2 ml.). In the absence of the pure substance, a glucosamine standard may be used and the result multiplied by a factor, namely, 1·78, 1·45 or 1·3 for measurements taken at 530, 520 or 510 mμ, respectively, to give the approximate concentration. Recoveries with solutions containing the substance and glucosamine or galactosamine were 98–101 per cent when compared with a standard of the pure amino-sugar. Acid hydrolysates of cell walls of vegetative *B. megatherium*, *B. subtilis* and *B. cereus*

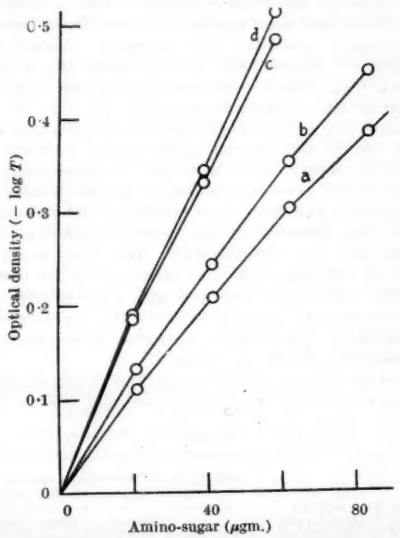

Fig. 2. Concentration/—log *T* relationships for the amino-sugar and glucosamine derivatives in the Elson and Morgan reaction: (*a*) amino-sugar at 530 mμ; (*b*) amino-sugar at 520 mμ; (*c*) glucosamine at 520 mμ; (*d*) glucosamine at 530 mμ

were found to contain 10, 11·6 and 4·3 per cent, respectively, of the amino-sugar.

Work on the identification of the substance is proceeding in this laboratory.

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Vitamin B_{12} Activity of *Chlorella vulgaris* Beij and *Anabaena cylindrica* Lemm

Microbiological tests by means of vitamin B_{12}-dependent bacteria and *Euglena gracilis* have shown that higher plants contain only traces (less than 1 μgm. per 100 gm. dry weight) of vitamin B_{12}, whereas microbiological activity corresponding to 10–50 μgm. vitamin B_{12} per 100 gm. dry weight has been reported in a number of algae.

Several substances, such as factor *A* and pseudo-vitamin B_{12}, are closely related chemically to cobalamin and capable of supporting growth of the bacteria and *Euglena* used for microbiological assay of the vitamin[1,2]; but they cannot replace cobalamin in the nutrition of higher animals[3]. Some micro-organisms are known to synthesize these substances as well as vitamin B_{12} itself[2,4]. The vitamin B_{12} activity of two algae was therefore investigated to determine whether this was due to cobalamin or to one or more of the related factors. Pure cultures of algae, which had been maintained free from bacteria during many transfers on inorganic media, were employed to ensure that any vitamin B_{12} activity detected must have originated from the synthetic activity of the organisms studied.

Vitamin B_{12} assays were carried out by a modification of the *E. coli* mutant plate-assay method[5], the solution for assay being obtained by extracting the algae with hot aqueous methanol in the presence of ammonia and cyanide. The nature of the substances present was determined by chromatography, ionophoresis and bio-autography[6]. By these tests the sample of *Chlorella vulgaris* was shown to contain 6·3 μgm. cobalamin per 100 gm. dry weight; no other compounds showing vitamin B_{12} activity could be detected. The results obtained with *Anabaena cylindrica* are shown in Table 1.

About 65–70 per cent of the activity of the *Anabaena* was due to vitamin B_{12}, the remaining effects being caused by the presence of pseudo-vitamin B_{12} and traces of factors *A* and *B*. In one experiment, cobalt (5 p.p.m.) was added to the medium to determine whether additional cobalt would allow synthesis of more vitamin B_{12}. Although the concentration of vitamin B_{12} was thereby almost doubled, scarcely any more total vitamin B_{12} activity was detected, because the dry-weight yield of alga was simultaneously depressed.

Table 1

Added cobalt	Total vit. B_{12} activity (*E. coli*) per gm. dry wt.	Activity of B_{12} and related substances (in terms of B_{12}) per gm. dry weight			
		Vit. B_{12}	Pseudo-vit. B_{12}	Factor *A*	Factor *B*
Nil	0·63 μgm.	0·44 μgm.	0·19 μgm.	trace	trace
5 p.p.m.	1·1 μgm.	0·70 μgm.	0·40 μgm.	trace	trace

The cobalamin content of *Chlorella* used in these studies is of the same order as the microbiological activity reported by Combs[7] for this organism: it indicates that the algae, grown under controlled conditions, may synthesize sufficient cobalamin to contribute to the dietary needs (up to about 5 μgm./100 gm. food) of higher animals and man.

The higher animals and many Protista, for which vitamin B_{12} is an essential nutrient, have been thought to be dependent on bacterial and fungal synthesis of the vitamin. The presence of cobalamin in at least two different algae may point to an alternative source of this nutrient, particularly for B_{12}-dependent organisms living in soil or water and for the food chains of animals living on these organisms.

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Influence of the Adrenal Cortex on Wool Growth and its Relation to 'Break' and 'Tenderness' of the Fleece

We were interested to know whether the adrenal cortex exerted a depressant action on wool growth in sheep. Such a mechanism might underlie the decline in wool growth observed in winter[1] and during pregnancy[2], since cold and gestation are known to increase adrenocortical activity in other species[3]. The marked increase in the number of active follicles which begins about ten days after birth in the lamb (Ferguson, K. A., Schinckel, P. G., Carter, H. B., and Clarke, W. H., in preparation) may possibly be due to release from adrenocortical inhibition. Field-observations link the occurrence of 'break' or 'tenderness' of the fleece[4] with disease, advanced pregnancy or environmental stresses which may be expected to stimulate secretion of adrenocorticotrophic hormone.

We have observed the effects on wool growth of treating sheep with adrenocorticotrophic hormone and with cortical steroids. The sheep were main-

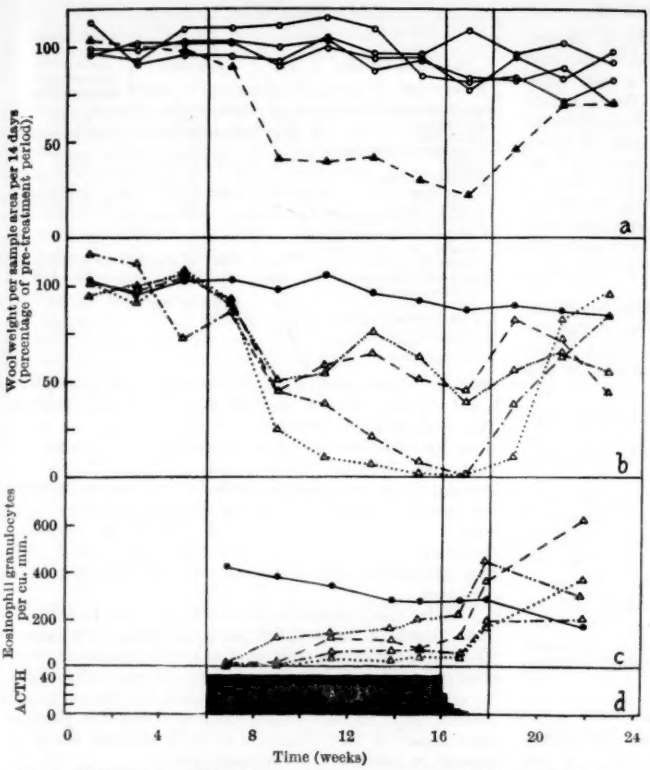

Fig. 1. Wool growth and blood eosinophil granulocyte count of sheep injected daily with adrenocorticotrophic hormone. (*a*) ○—○, untreated; ▲- - -▲, treated (mean); (*b*) and (*c*), ●—●, untreated (mean); △—·—△, *A* 91; △——△, *A* 79; △—··—△, *A* 84; △····△, *A* 89; (*d*) dose of adrenocorticotrophic hormone in I.U./sheep/24 hr.

tained in pens on a constant food intake. Wool growth was measured by the periodic clipping of a sample area defined by tattoo lines. Four ewes received daily intramuscular injections of 40 I.U. of long-acting adrenocorticotrophic hormone (Acton) for ten weeks.

The results are shown in Fig. 1. Wool growth was significantly decreased in the treated sheep ($P < 0{\cdot}01$). In two sheep, wool growth diminished progressively until completely arrested, and rose sharply after cessation of treatment. In the other two animals, a degree of refractoriness developed after an initial decrease in wool growth. Fibre thickness and length growth were reduced and histological sections revealed many follicles that had shed their fibres and undergone varying degrees of involution. Primary follicles shared this effect, though to a lesser degree than secondary follicles. Coinciding with the resumption of wool growth as determined on the sample area, a 'break' appeared in the fleece above the surface of the skin in all sheep treated. Numerous shed roots and new growing tips resembling those of lambs' wool were discernible microscopically in this part of the staple, whereas other fibres, though continuous through the region of break, were reduced in diameter.

The number of circulating eosinophils was reduced by treatment with adrenocorticotrophic hormone. This reduction was less persistent in those sheep showing refractoriness to treatment, suggesting that the adrenals of these sheep were unable to respond to continued intense stimulation. No refractoriness has been noted in four sheep treated with cortisone. The serum of a sheep refractory to adrenocorticotrophic hormone failed to protect hypophysectomized rats against the effect of the hormone in restoring the weight of adrenals, indicating that antibodies to the hormone were not the cause of the refractoriness.

A response resembling that to adrenocorticotrophic hormone was produced in four ewes by the daily intramuscular injection of 1·8 mgm. cortisone acetate per kgm. body-weight for eight weeks. Again the appearance of the 'break' above the skin coincided with the resumption of wool growth four to six weeks after cessation of treatment. The local application of an ointment containing 0·1 per cent of 9-α-fluorohydrocortisone (Merck) to the sample area on three sheep suppressed wool growth and induced local skin changes resembling those produced by the systemic treatments described, while normal wool growth continued on sample areas sham-treated with the ointment base on the opposite sides of the same sheep. Treatment of other sheep with a 2·5 per cent hydrocortisone ointment (Merck) produced a much smaller response.

Experiments are in progress to determine whether the cortical secretion of the normal sheep is sufficient to limit wool growth. Comparisons are being made of the wool growth of adrenalectomized sheep maintained on different levels of cortisone and deoxycorticosterone.

The above experiments suggest that a temporary hyperactivity of the adrenal cortex may be a common physiological mechanism underlying the occurrence in the field of 'tenderness', 'break', 'rising of the fleece', and possibly the 'cotted fleece'. However, the degree of adrenocortical stimulation which occurs following natural stresses which cause 'break' remains to be determined. Further investigation is also required to test whether variations in adrenal cortical activity are of importance in determining natural variations in wool growth, such as those due to individuality, breed, nutrition, gestation and season.

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Zinc in Aspermic Human Semen

Normal human seminal plasma has been shown to contain a higher concentration of zinc than any tissue except sperm[1]. The sperm contain a very high concentration of zinc, but their removal from semen by centrifugation causes no significant reduction in the zinc concentration of the fluid because of their small relative volume. No previous opportunity had occurred for analysis of naturally aspermic semen, but recently a specimen of this nature was received. It had not been collected in specially cleaned glassware, but any contamination due to this fact could not have added more than a few μgm./ml. to the zinc content.

The centrifuged deposit from the whole specimen was examined by phase microscopy and by the staining method of Isenberg[2] and found to contain a few epithelial cells, but no sperm. The volume of the semen was 5 ml.

Zinc was estimated in 1 ml. of the plasma by the method of Vallee and Gibson[3]. The dry weight was 7·6 gm./100 gm. and the zinc concentration 234 μgm./ml. This result did not differ significantly from normal: four specimens of normal human seminal plasma contained 134 ± 59 (S.D.) μgm. zinc/ml.

It is known that dietary zinc deficiency will cause a reduction of androgenic hormone production and aspermia in rats[4]. The wide distribution of zinc in Nature makes dietary zinc deficiency in man very improbable, and the normal volume and the high zinc content of this semen suggest normal prostatic function. The donor was clinically normal, with no evidence of androgenic insufficiency.

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Reticulocyte Enzymes and Protein Synthesis

The hæmoglobin of red cells appears to be synthesized during the early stages of maturation, and its formation is more or less complete by the time the cells leave the bone marrow. Although reticulocytes have practically their full complement of hæmoglobin, evidence from amino-acid incorporation studies[1] suggests that these cells, unlike mature erythrocytes, still have protein-synthesizing capacity. In view of this, it was felt that it would be of interest to see if certain enzymes were at a high level of activity in reticulocytes; Table 1 summarizes the results of a preliminary investigation of the level of activity in the two types of cell for a number of enzymes which might be involved in some way in a protein-synthesizing mechanism.

In addition to the enzymes shown, attempts were made to detect glutamine synthetase and enzymes synthesizing glutathione. However, under the conditions of assay which were tried, such activities were not detected in either erythrocytes or reticulocytes.

The phosphatases listed in Table 1 were investigated in view of the possibility that their *in vivo* function

Table 1

Enzymatic activity	*p*H	Activator	Approximate increase in activity in reticulocyte preparations
Cathepsin	3·2	none	6-fold
Cathepsin	7·5	0·001 *M* Zn^{++}	no increase
Glycylglycine dipeptidase	7·8	0·001 *M* Co^{++}	8-fold
Leucine aminopeptidase	7·8	0·001 *M* Mn^{++}	2-fold
Tripeptidase	7·1	none	2- to 3-fold
Liberation of inorganic phosphate from adenosine tri-, di- and mono-phosphate	7·5	0·001 *M* Mg^{++}	2- to 3-fold
Acid phosphatase	6·0	none	3- to 5-fold
Alkaline inorganic pyrophosphatase	7·5	0·025 *M* Mg^{++}	8-fold
Acid inorganic pyrophosphatase	5·2	none	12-fold

may be concerned with the transfer of phosphate bond energy utilized in the linking of amino-acids. The reticulocyte preparations were similar to those used in the amino-acid incorporation studies of Borsook[1], that is, preparations of rabbit blood containing 70–90 per cent reticulocytes, obtained following reticulocytosis induced by phenylhydrazine. The assays were carried out on whole hæmolysates obtained by freezing and thawing the washed cells, and activities were expressed per milligram of protein nitrogen.

During the transition from reticulocyte to erythrocyte, much of the cellular protein, other than hæmoglobin, disappears, and it might be expected that, relative to total protein nitrogen, a generally higher level of enzymatic activity might be found in the former type of cell. This may account for the fact that most of the enzymes studied showed some increase in activity in reticulocytes.

However, from Table 1 it is apparent that some enzymes are increased to a greater extent than the others: namely, cathepsin active at *p*H 3·2, one particular peptidase (glycylglycine dipeptidase), and inorganic pyrophosphatase.

The possibility that cathepsins have a synthetic function has long been considered, and there appears to be some correlation between the rate of growth, or of protein synthesis, and the level of catheptic activity in various tissues[2,3]. On the other hand, recent reports that cathepsins are mitochondrial enzymes[4] are not in accord with a protein-synthesizing function, as the latter process appears to be associated with microsomal particles. It has been suggested[3] that catheptic activity is concerned with the provision of free amino-acids for utilization in protein formation, rather than with the synthetic mechanism itself.

The observation of a specific increase in dipeptidase activity is of interest in relation to recent reports by Binkley[5], who, in the course of attempts to purify cysteinyl glycinase from swine kidney, obtained a soluble fraction which possessed a very high non-specific dipeptidase activity and which was apparently non-protein in nature. This material exhibited some of the properties of a polynucleotide, and in view of this, it was suggested that *in vivo* the activity might be related to protein biosynthesis.

Among the phosphatases studied, the largest increases were found in the case of the inorganic pyrophosphatases. This observation may have a bearing on results obtained by Hoagland and Keller[6], who have formulated the following scheme for the carboxyl activation of amino-acids (detected in their experiments by hydroxamate formation):

$$E + ATP \rightleftharpoons E(AMP—PP)$$
$$E(AMP—PP) + AA \rightleftharpoons E(AMP—AA) + PP$$
$$E(AMP—AA) + NH_2OH \rightleftharpoons E + AMP + AA—NH.OH$$

If the activation of amino-acids prior to incorporation into protein takes place by a general mechanism such as the above, then a function for the intracellular pyrophosphatase is apparent: to split the inorganic pyrophosphate formed, thus providing free orthophosphate for utilization in the regeneration of adenosine triphosphate (presumably through a concomitant glycolytic process). The higher inorganic pyrophosphatase activity in reticulocytes could be related in this way to the protein-synthesizing capacity of these cells.

Detailed reports on the above investigations are in preparation for submission to the *Biochemical Journal*. This work is supported by a grant from the Secretary of State for Scotland on the recommendation of the Advisory Committee on Medical Research.

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Polyembryony in *Cassia*

DURING an investigation into a presumed hybrid swarm among *Cassias*[1], seeds with twin embryos were found. An examination of the seeds of different species of *Cassia* that were available has shown the occurrence of polyembryony to be geographically widespread and remarkably common within several species. Table 1 gives the percentage of twins and triplets (in brackets) found in different collections of fifty to a hundred seeds.

Table 1. PERCENTAGE OF TWINS AND TRIPLETS (IN BRACKETS) IN DIFFERENT COLLECTIONS OF SEED

Australian species of *Cassia*	1	2	3	4	5
C. artemisioides Gaud.	10 (1)	25	10 (1)	23 (3)	8
C. australis var. *revoluta* Benth.	0				
C. desolata var. *involucrata* J. M. Black	16 (1)				
C. eremophila A. Cunn	40 (2)	20 (2)	5	24	
C. phyllodinea R. Br.	14 (1)				
C. sturtii R. Br.	3	21	9	40 (4)	14 (2)

The exotic species *C. bicapsularis*, *C. cana*, *C. corymbosa*, *C. fistula* and *C. leptophylla* contained no twins in single samples of fifteen to fifty seeds.

Among the twins and triplets the embryos varied from equality in size to one large and one small, and one large and two small respectively, gross inequality being the general case. Fused embryos and others with extra or reduced cotyledons were also frequent. The pairs of large twins at least were viable.

These extra embryos could arise from several sources. The occurrence of cleavage polyembryony or of several embryo sacs would not be apomictic in nature, but the first case would lead to the production of identical twins as would apomictic embryos. The latter could have developed from cells of the nucellus and integuments, or in some cases from the synergids. Twins arising from several embryo sacs would not be identical. However, many genera are facultative apomicts, and both sexual and apomictic reproduction may occur simultaneously[2]. Evidence for this in *Cassia* was indicated when one plant, presumed to be a hybrid on morphological characters, failed to segregate but produced twins and other abnormal seedlings, while a second plant produced morphologically different seedlings from each of two pairs of twins.

All the Australian species listed belong to the section *Psilorhegma*, which is well developed in Australia, but the varied biotypes of which have resulted in taxonomic confusion, particularly in the species complex centred about *C. sturtii*. The preservation of the intermediates could be the result of both apomixis and of sexual reproduction.

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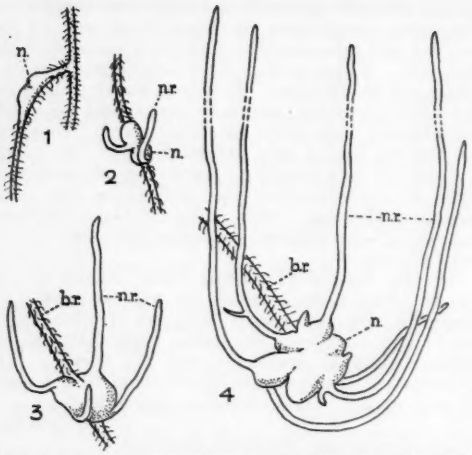
A Feature of the Root Nodules of *Casuarina*

IN the course of an investigation into the development and physiological activity of the root nodules of *Casuarina*, considerable numbers of nodulated plants of *C. cunninghamiana* and *C. equisetifolia* are being grown in water culture. Nodulation was secured by inoculating the roots of young plants with a suspension of crushed *Casuarina* nodules obtained from abroad through the assistance of Dr. H. R. Fletcher, of the Royal Botanic Garden, Edinburgh, and commenced three to four weeks after such inoculation. McLuckie[1] noted a resemblance between *Casuarina* and *Myrica* root nodules in that both show a lobed structure as the result of repeated branching (actually this is true of most non-legume and some legume nodules) and in that a root grows out from each nodule lobe.

An interesting feature which has emerged from the present study is that these nodule roots show strongly upward growth, as illustrated in Figs. 1–4. In some cases the roots (which bear few or no root hairs) have attained a length of 10 cm. and may project from the surface of the culture solution even when originating from quite deeply set nodules. Precisely similar features have been recorded previously for *Myrica gale*[2] growing under a variety of cultural and under field conditions. In that species the upward growth of the nodule roots was shown to be the result of negative geotropism (not of ageotropism, as stated in a recent review[2]), and was thought to be possibly of significance in the ventilation of the nodules, which are otherwise enclosed in a layer of cork tissue. The general position seems to be much the same in *Casuarina*.

It is somewhat surprising that this unusual pattern of root behaviour should be repeated in such unrelated plants as *Casuarina* and *Myrica*, resulting in the nodulated root systems of young plants being virtually indistinguishable from each other externally. A further resemblance is that the nodules of *Casuarina* also are frequently pink in colour. I have no oppor-



Figs. 1–4 show successive stages in the development of nodules and nodule roots in *Casuarina equisetifolia*, orientated as they had grown. *n.* = nodule; *n.r.* = nodule root; *b.r.* = root (with root hairs) bearing nodule. (× 10 approx.)

tunity for examining field material of *Casuarina* nodules *in situ* to ascertain whether the upward growth of the nodule roots is shown under natural conditions. It is probable that such would prove to be the case; but it would be necessary to examine newly formed roots, since the original orientation may no longer be shown in old, moribund roots.

Other observations on *Casuarina* nodules, which according to the work of Aldrich-Blake[4] and of Mowry[5] are nitrogen-fixing, will be presented elsewhere, along with full acknowledgments for assistance received.

G. Bond

Department of Botany,
University, Glasgow. Sept. 27.

[1] McLuckie, J., *Proc. Linn. Soc. New South Wales*, **48**, 194 (1923).
[2] Bond, G., *Ann. Bot.*, N.S. **15**, 447 (1951); **16**, 467 (1952). Fletcher, W. W., *Ann. Bot.*, N.S., **19**, 501 (1955).
[3] Allen, E. K., Gregory, K. F., and Allen, O. N., *Can. J. Bot.*, **33**, 139 (1955).
[4] Aldrich-Blake, R. N., *Oxford Forestry Memoirs*, **14**, 1 (1932).
[5] Mowry, H., *Soil Sci.*, **36**, 409 (1933).

Inhibition of Salt Absorption in Red Beet Root Tissue

Rees and Skelding[1] have reported that extracts of red beet root tissue inhibit the absorption of salts by this material. They claimed that the extracts do not affect respiration, and attributed the influence to a non-metabolic effect on permeability. It was suggested that the inhibitory principle is responsible for natural dormancy in beet roots, and for the inability of freshly cut disks of dormant tissue to absorb salts actively. In an intensive investigation of this problem during the past two years, we have confirmed the main inhibitory effect, and have suggested a probable cause. It is hoped that a full account of the work will be published elsewhere.

In this investigation, the uptake of potassium ions by disks of red beet root tissue has been examined using techniques already described[2]. Rates of respiration were determined in parallel experiments with a standard Warburg apparatus. The tissue extracts were prepared essentially as described by Skelding and Rees. In all cases the potassium content of the experimental solutions and controls was brought initially to 0·02 *N*, usually by the addition of an appropriate amount of potassium chloride, although occasionally, as indicated below, other salts of potassium were used. A small amount of sodium chloride was added to the control solutions to compensate for the sodium present in the tissue extracts. Competition with hydrogen ions was controlled by bringing all the solutions initially to *p*H 6, by addition, where necessary, of a small amount of potassium hydroxide. Uptake- and respiration-rates were generally determined over an experimental period of 6 hr. at 25° C.

It may be observed from Fig. 1 that, in the presence of tissue extract, the uptake of potassium was reduced. At the same time there was a considerable stimulation of oxygen absorption. Dilution of the extract caused reduction of the inhibition and a decreased respiratory effect. A similar stimulation of respiration by extracts of red beet has already been reported by Bennet-Clark and Bexon[3]. The absence of an effect in the experiments of Skelding and Rees seems somewhat surprising in view of these observations.

During the present work, the respiratory and salt inhibitory effects of the extract have been separated to some extent by ether fractionation. It has become evident that a large part of the stimulation of oxygen uptake is attributable to sugars, and perhaps other respiratory substrates which do not inhibit salt uptake. On the other hand, fractions of the extract which cause inhibition invariably retain a significant stimulatory effect on respiration. These fractions contain large amounts of organic acids, chiefly malic and citric, which have been separated and identified chromatographically. It is claimed that these are chiefly responsible for the inhibition of ion uptake, and the residual respiratory effect.

The slower uptake of cations from solutions of single salts containing a relatively immobile anion is a well-known phenomenon. Uptake of potassium from a solution containing chloride may be compared with that from a solution of malate from the results in Table 1. Table 1 also shows that potassium uptake in the presence of a tissue extract is inhibited when compared with the uptake from potassium chloride, but not inhibited when compared with the uptake from potassium malate. This is true whether the potassium content of the extract is made up initially by the addition of either potassium chloride or potassium malate. A similar effect has been observed with other organic acids, including citric and succinic acids.

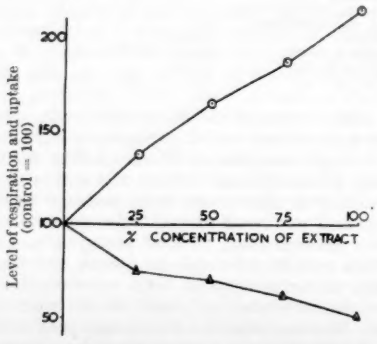


Fig. 1. Effect on disks of red beet root of extracts of the same tissue. Respiration, ○; uptake of potassium, △. 6 hr. at 25° C.

Table 1. Uptake of potassium ions (μequiv. per gm. fresh weight) from solutions of different salts, and in the presence of tissue extracts, in 6 hr., at 25° C.

Solution	Uptake	S.E.
Potassium chloride	44·4	± 0·57
Potassium malate	30·9	± 0·07
Tissue extract + chloride	34·4	± 0·26
Tissue extract + malate	29·7	± 0·18

It is concluded that the apparent inhibitory effect of tissue extracts of red beet is mainly attributable to association of a proportion of the cations present with organic anions, which are absorbed more slowly than chloride and cause a retardation in the rate of uptake of cations.

In later experiments we have observed that extracts prepared from actively growing roots of the beet, and also from disks with a strong accumulatory ability, show inhibitory effects on cation uptake which are not significantly different from those exhibited by extracts from dormant roots. These observations indicate that the inhibition is without significance either in relation to the life-cycle of the beet plant, or to the development of an absorptive capacity in tissue disks.

One of us (J. E. D.) wishes to thank the Agricultural Research Council for permission to publish this communication.

J. E. Dale
J. F. Sutcliffe

Department of Botany,
King's College,
London, W.C.2. Sept. 30.

[1] Rees, W. J., and Skelding, A. D., *Nature*, **166**, 823 (1950). Skelding, A. D., and Rees, W. J., *Ann. Bot.*, N.S., **16**, 513 (1952).
[2] Sutcliffe, J. F., *J. Exp. Bot.*, **3**, 59 (1952).
[3] Bennet-Clark, T. A., and Bexon, D., *New Phytol.*, **42**, 65 (1943).

Virulent Attacks of Eyespot on Oats

Oats, although known to be occasionally attacked by eyespot caused by *Cercosporella herpotrichoides*, are generally regarded as very resistant to this disease, and hence are usually considered the safest crop to follow wheat or barley where intensive cereal cultivation is being carried on. In view of this statement, the following observations on disastrous attacks of *Cercosporella herpotrichoides* on oats may be of interest.

During a survey of cereal crops in 1955 and the incidence of eyespot in Ireland, numerous crops of oats were reported as badly affected by lodging. A microscopical examination of specimens from eighteen crops confirmed the presence of *Cercosporella herpotrichoides* as the causative agent, the take-all fungus *Ophiobolus graminis* being present in one sample. The lodged crops were widely distributed over twelve counties: in nine cases the number of affected plants was more than 80 per cent, and in some of these the entire crop had gone down; the remaining nine crops had lodged patches of varying extent.

All crops were spring sown, that is, in March or April, and the varieties were Victory, Sun II and Glasnevin Triumph, the rotation being:

1 crop oats, following three successive barley crops;
4 crops, each following three successive wheat crops;
3 crops, each following two successive wheat crops;
4 crops, each following one year wheat after ley;
2 crops, each following one year wheat after roots;
1 crop, the third successive crop of oats;
2 crops, each following wheat, no other particulars;
1 crop, no particulars.

Although typical eyespot lesions occurred to some extent on the oat plants, they were rather scanty; but frequently an indented line was present on one or both sides of the culm. This indentation presented the appearance as if the culm had been pressed in with the thumb-nail, the dent extending up the plant from the base to a height of one to three inches, and sometimes causing a split in the culm. When such stems were cut longitudinally, the fungus was often visible to the naked eye in the central cavity, and, as a rule, more profusely developed than occurred in either affected wheat or barley.

This attack on oats was no doubt closely connected with the prevailing climatic factors. Weather conditions in the autumn of 1954 and the following winter were such as to preclude ploughing. March and April in 1955 were favourable for cultivation, but both May and June were wet. In fact, the last mentioned was the wettest June since 1928 and the nights were unusually cold. Rain fell early in July, but then the weather suddenly changed and came in exceptionally warm, and it continued so throughout August. Lodging of diseased crops commenced towards the end of the third week in July, and as the very warm weather continued, more and more cases were reported. The collapse of the plants was sudden and spectacular on many farms, lodging of most of the crop occurring within two or three days. As no rain had fallen during the previous three weeks in many districts, the occurrence naturally aroused the growers' interest. The various county instructors in agriculture were then consulted, and due acknowledgment is made to them for assisting in this investigation.

In a previous communication[1], Miss Glynne reported a severe attack of sharp eyespot on oats due to *Corticium solani*. We, however, are not aware of any record in plant pathological literature of widespread attacks of ordinary eyespot on oats such as described, and it would seem as if our views on the resistance and liability of oats to *Cercosporella herpotrichoides* will have to be considerably modified.

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[1] Glynne, Mary D., *Nature*, **166**, 232 (1950).

Spawning of the Sardine at a Definite Time of Day

The sardine is the principal food-fish of the lands bordering the Adriatic Sea. It is fished only from April to September, since it disappears from the fishing grounds from October to March. This period is the spawning time, when it migrates to regions hitherto unknown. The eggs float in the upper layers of the sea and are therefore found in the plankton. We have now been able to determine the spawning areas by means of systematic plankton studies throughout the Adriatic[1]. In the course of this work, it was found that the sardine (*Sardina pilchardus*) spawns at a certain time of day, namely, in the evening. This is an extension of the finding of Ahlstrom[2] for the Californian sardine (*Sardinops caerulea*). Since the phenomenon seems to be unknown in other marine fishes, we think it worth while to describe our method and results.

Plankton samples were taken hourly for a period of 48 hr. at one spawning place on two occasions.

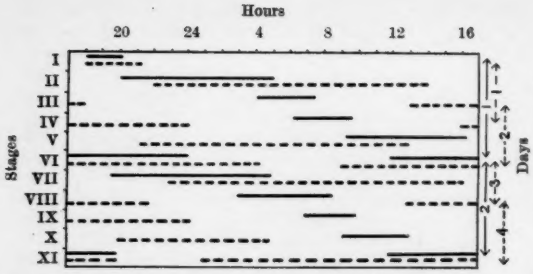

Fig. 1. Duration of embryonic development in the sardine: ———, in December at 18° C.; – – – –, in March at 13° C.

The first occasion was in December and the second in March. These dates were selected because at the place chosen the water temperature is then uniform from surface to bottom: in December it was 18° and in March 13° C. Thus the temperature conditions were as constant as in a laboratory experiment. We made use of the eleven embryonic stages of Ahlstrom, since the development of the two species is similar. Our results are shown diagrammatically in Fig. 1. Hatching takes place after stage XI. It will be seen from Fig. 1 that at 18° C. the duration of embryonic development is nearly two days, and at 13° C. about three and a half days. It is also clear that spawning takes place in the evening.

We have some evidence, deduced from studies of planktonic ova, of the occurrence of spawning at a definite time of day in yet other species of fish, especially pelagic ones, but the data are as yet incomplete. A full account of the work on the sardine will be published in *Acta Adriatica*, volume 7.

T. Gamulin
J. Hure

Oceanographic Station,
Dubrovnik, Yugoslavia.
Sept. 30.

[1] Gamulin, T., *Rep. Inst. Oceanog., Split*, No. 4 C (1954).
[2] Ahlstrom, E. H., Spec. Sci. Rep. No. 23, Fish and Wildlife Service, U.S.A. (1943).

Swimming of Fishes

The 'load carried' by a nursehound *Scyllium catulus* is approximately 5 per cent in this fish, and fishes closely related to it; only 95 per cent of the weight of the fish (in air) is supported by the water. In most teleosts (with swim-bladders), such as the conger, the load carried is about 0·01, or practically the whole of the weight is supported by the water[1].

A large nursehound lends itself to the simple experiment of hanging additional weights on to it and ascertaining how much additional weight it can carry. This was done recently in one of the large outside tanks at the Marine Biological Association at Plymouth, when it was found that a large nursehound could carry an additional weight amounting to practically 25 per cent of its weight in air, while a teleost was practically incapable of carrying anything.

Thus a nursehound has an enormous reserve of carrying power, while most teleosts (with swim-bladders) have practically none.

A. G. Lowndes

Probus School,
Probus, Truro.
Sept. 13.

[1] Lowndes, A. G., *Ann. and Mag. Nat. Hist.*, **8**, 241 (1955).

Nomenclature in Microscopy

Some confusing terms are used nowadays in microscopy. One repeatedly sees and hears the expression 'light-microscopy' used with the intention of excluding phase-contrast and dark-ground, as though these methods did not involve the use of light. One also notices the expression 'phase-contrast illumination', which is used despite the fact that the essential part of the method occurs at or near the upper focal plane of the objective.

We need a universally recognized word for what is sometimes called 'ordinary' microscopy. The word 'ordinary' is not very suitable, because other methods are coming into wide favour. It might be convenient to speak of 'direct' microscopy in all cases in which (1) there is only one illuminating cone, arranged symmetrically about the optical axis, and (2) the direct and diffracted light are not treated differently. Direct microscopy would be in contrast with 'oblique', 'dark-ground' and 'interference' microscopy.

In 'oblique' microscopy the direct rays are sent through the optical system in such a way that their course is not symmetrical about the optical axis.

In 'dark ground' microscopy the direct rays are either so directed as to miss the lenses of the objective by passing externally to them (external dark-ground), or else they are stopped within or just above the objective (internal dark-ground). What is here called internal dark-ground is commonly called 'central dark-ground'; but the term is not fortunate, for an annular stop is preferable to a central one. ('Dark-ground' seems preferable to 'dark-field', because it is only the background, not the whole field of view, that is dark.)

'Interference' microscopy is also of two main kinds. In one, which may be called 'double-beam interference', two coherent sets of rays are used for illumination. In the other, a single (hollow) illuminating cone is used, and the second set of rays, with which the direct rays will be caused to interfere, originates at the object. This is 'single-beam interference', but the name 'phase-contrast' is (unfortunately) firmly established.

It would be a convenience to limit the expression 'light-microscopy' to cases in which visible light is the illuminant. If one did not state or suggest the contrary, it could be assumed that the illuminant was light. Thus, the unqualified expression 'dark-ground microscopy' would mean dark-ground microscopy with visible light. The various terms suggested in the preceding paragraphs would be (potentially) as applicable to infra-red, ultra-violet and electron-microscopy as to light-microscopy.

It would be consistent to restrict the term 'photomicrograph' to micrographs made with visible light, and thus to speak always of infra-red, ultra-violet and electron 'micrographs'. The expression 'electron photomicrograph', which one sometimes sees in scientific papers, is objectionable.

I thank Mr. W. Galbraith for criticism of the first draft of this communication.

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University Museum,
Oxford.
Sept. 28.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 30

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "Hypothermia".

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. A. Nizet (Liège): "Hæmopoiesis and General Protein Metabolism".*

ROYAL INSTITUTION, LIBRARY CIRCLE (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. Geoffrey Parr: "What Constitutes a Technical Best-Seller ?"

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Prof. Sir Mortimer Wheeler: "East Africa's Ancient Past" (Mrs. Will Gordon Lecture for 1956).

Tuesday, January 31

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. McKie: "Science in Eighteenth-Century Paris".*

FAUNA PRESERVATION SOCIETY (in the Mappin Terrace Pavilion, Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—General Meeting. Mr. J. A. Hislop: "Some Animals of Malaya".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Sir Gilbert Rennie: "Recent Developments in the Federation of Rhodesia and Nyasaland".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—M. Jean Gerard: "La Co-opération Technique Européenne" (Jubilee Memorial Lecture).

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. A. M. Godridge, Dr. R. Jackson and Mr. G. G. Thurlow: "Industrial Measurement of Gas Temperature".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. Edwards: "Laminar Flow Aircraft Design".

Wednesday, February 1

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. L. L. Hall and Mr. S. G. Young: "Civil Engineering Aspects of Radio Stations' Work".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. J. L. Gillams: "The Harnessing of Nuclear Power for Industry".*

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the SOUTH-WEST ESSEX TECHNICAL COLLEGE CHEMICAL SOCIETY, at the South-West Essex Technical College, Forest Road, London, E.17), at 7 p.m.—Mr. J. S. Hughes and Mr. R. L. Bass: "Silicones—their Manufacture, Application and Analysis".

Thursday, February 2

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Mary Whitear: "On Being a Fish".*

CHEMICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m. and 7.30 p.m.—Symposium on "Recent Advances in the Chemistry of Colouring Matters".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. K. H. L. Erhard and Prof. R. G. W. Norrish, F.R.S.: "Studies of Knock and Antiknock by Kinetic Spectroscopy"; Mr. F. J. L. Lipscombe, Prof. R. G. W. Norrish, F.R.S., and Mr. B. A. Thrush: "The Study of Energy Transfer by Kinetic Spectroscopy. 1: The Production of Vibrationally Excited Oxygen".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. E. L. E. Wheatcroft and Mr. H. H. C. Barton: "The Potentialities of Railway Electrification at the Standard Frequency".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. J. E. Gordon: "New Ideas in Plastics for Aircraft Structures".

Friday, February 3

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 408, Birkbeck College, Malet Street, London, W.C.1), at 7.30 p.m.—Informal discussion on Mr. Alec Rodger's British Association paper—"The Effective Use of Manpower". Opening Speaker: Mrs. H. S. Anthony.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. H. Munro Fox, F.R.S.: "The Moon and Life".

Saturday, February 4

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Gwynne Vevers: "Life in the Sea".*

BRITISH INTERPLANETARY SOCIETY (in the York Hall of Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Mr. T. D. Bourdillon: "Portable Breathing Apparatus".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with a good honours degree and teaching experience, and preferably with industrial or research experience) IN PHYSICAL or ORGANIC CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (February 4).

LECTURER (with an honours degree in metallurgy of a British university or equivalent, together with some teaching experience, and experience of metallurgical research or industry) to specialize in the teaching of general and industrial metallurgy—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (February 4).

SUPERINTENDING SCIENTIST (with a university degree of high standing in physical science engineering or mathematics, and extensive experience in research and development work and in the direction of such work) at the Weapons Research Establishment, Department of Supply, Salisbury, South Australia, to supervise groups engaged in research and development in the fields of electronics, optics and electro-mechanical devices—Senior Representative (AP43), Department of Supply, Australia House, Strand, London, W.C.2 (February 6).

ASSISTANT (preferably with an honours degree in science or agriculture) IN THE CHEMISTRY DEPARTMENT at Auchincruive, for work mainly relating to the analysis of soil and other agricultural materials—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (February 8).

LECTURER IN GENETICS—The Secretary of University Court, The University, Glasgow (February 11).

PHYSICIST (with a first- or second-class honours degree or equivalent in physics), at the Ministry of Supply Chemical Defence Experimental Establishment, near Salisbury, Wilts, for research on problems involving optics, heat transfer or radiation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.4/6A/AA (February 11).

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in biochemistry or in a biological subject with subsidiary chemistry, or with evidence of outstanding ability) at the Ministry of Agriculture, Fisheries and Food in London—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4549/56 (February 16).

LECTURER IN EDUCATION—The Registrar, The University, Reading (February 18).

LECTURERS (2) IN STATISTICS—The Secretary, The University, Aberdeen (February 18).

PROFESSOR OF PSYCHOLOGY—The Registrar, University Registry, Oxford (February 23).

ASSOCIATE PROFESSOR IN SOIL SCIENCE at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 25).

LECTURER (with an honours degree in physical chemistry or equivalent qualification) IN PHYSICAL CHEMISTRY, at the School of Mines and Industries, Adelaide—The Agent General and Trade Commissioner, South Australia House, Marble Arch, London, W.1 (February 27).

ASSISTANT LECTURER OR LECTURER IN PURE MATHEMATICS—The Secretary and Registrar, The University, Southampton (February 28).

ASSOCIATE PROFESSOR OF SOIL SCIENCE in the Faculty of Agriculture, University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 28).

LECTURER (preferably with experience in the field of plant physiology with special reference to agriculture, and some training in agriculture as well as botany) IN PLANT PHYSIOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 29).

LECTURER (with at least an honours degree in mathematics, and specialized in either pure or applied mathematics) IN MATHEMATICS at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 29).

RESEARCH FELLOW IN THE DEPARTMENT OF ZOOLOGY AND COMPARATIVE PHYSIOLOGY—The Registrar, The University, Birmingham (February 29).

SENIOR LECTURER IN CLINICAL BIOCHEMISTRY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 29).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN PHYSICS, CHEMISTRY, ENGINEERING, METALLURGY and PHARMACOLOGY, or any related subject; three LEVERHULME POSTGRADUATE FELLOWS (two in the Faculty of Science and one in the Faculty of Engineering); and RESEARCH FELLOWS IN NUCLEAR PHYSICS—The Registrar, The University, Liverpool (March 1).

RESEARCH FELLOW IN BOTANY OR IN ZOOLOGY—The Registrar, The University, Nottingham (March 1).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (March 3).

ASSISTANT LECTURERS (2) (one in pure and the other in applied mathematics) IN MATHEMATICS—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (March 30).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN BACTERIOLOGY, BIOCHEMISTRY, BIOMOLECULAR STRUCTURE, BOTANY (Plant Biochemistry and Biophysics), CHEMICAL ENGINEERING, CHEMISTRY, CHEMISTRY OF LEATHER MANUFACTURE, CHEMOTHERAPY, COLOUR CHEMISTRY AND DYEING, ENGINEERING (Civil, Electrical or Mechanical), FUEL AND REFRACTORIES, GEOLOGY (including Geochemistry), METALLURGY, MINING (Selective Flotation and Geophysical Surveying), PHARMACOLOGY, PHYSICS, PHYSIOLOGY or TEXTILE INDUSTRIES CHEMISTRY OF HIGH POLYMERS (keratin and man-made fibres), TEXTILE TECHNOLOGY AND WOOL TEXTILE ENGINEERING—The Registrar, The University, Leeds 2 (April 14).

IMPERIAL CHEMICAL INDUSTRIES FELLOWS IN PHYSICS, CHEMISTRY, COLLOID SCIENCE, BIOCHEMISTRY, ENGINEERING, METALLURGY,

PHARMACOLOGY, CHEMOTHERAPY, or related subjects—The Secretary General of the Faculties, The Old Schools, Cambridge (April 30).

ASSISTANT (Grade B) IN PHARMACEUTICS, and an ASSISTANT (Grade B) IN THE DEPARTMENT OF MATHEMATICS at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

CHEMIST/ASSAYER IN THE DEPARTMENT OF GEOLOGICAL SURVEY, Gold Coast Local Civil Service, to take charge of the Geological Survey Chemical Laboratory; to assay ore; to carry out silicate analyses of rocks and minerals; to participate in research in the inter-relation of Gold Coast rocks and in geochemistry—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.105/13/06.

CHEMIST (with a first- or second-class honours degree or equivalent, and at least three years general industrial experience) at the Central Laboratory, Chiswick—Recruitment and Training Officer (F/EV 550), London Transport, 55 Broadway, London, S.W.1.

GENETICIST, Scientific Officer or Senior Scientific Officer grade (with at least a second-class honours degree in botany or other natural science and some years experience in plant breeding and genetics, and preferably experience with tropical perennial crops or maize breeding), at the West African Institute of Oil Palm Research, Nigeria, to carry out research under a senior geneticist in charge of his division, directed towards improving the oil palm by selection and breeding—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.197/199/012.

LECTURER IN PHYSICS—The Clerk, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN REFRIGERATION at the National College for Heating, Ventilating, Refrigeration and Fan Engineering—The Clerk to the Governors, Borough Polytechnic, Borough Road, London, S.E.1.

PHYSICAL CHEMIST or PHYSICIST (with a first- or second-class honours degree or equivalent qualification in physical chemistry or physics), at a Ministry of Supply Armament Research and Development Establishment near Sevenoaks, Kent, for research on initiation of explosive systems and in application to Service stores—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.963/5A/AA.

SCIENTIFIC ASSISTANT (with a good science degree, a reading knowledge of two European languages (of which one should preferably be other than French or German) and ability to write good English), for work in scientific information service involving abstracting and indexing—The Director, Commonwealth Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts.

SENIOR RUBBER TECHNOLOGIST (with a good degree, substantial experience in the rubber industry, evidence of research ability, and eagerness to co-operate with colleagues engaged on basic chemical and physical research), for research and applicational studies in the dry rubber field—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

SENIOR TECHNICIAN IN ZOOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

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Great Britain and Ireland

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